UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
1201 NE Lloyd Boulevard, Suite 1100
PORTLAND, OREGON 97232

Refer to NMFS No: WCRO-2019-00175

September 25, 2019

Hanh Shaw
Water Quality Standards Unit Manager
U.S. Environmental Protection Agency
Region 10
1200 Sixth Avenue, Suite 155
Seattle, Washington 98101

Re: Endangered Species Act Section 7(a)(2) Biological Opinion, and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the U.S. Environmental Protection Agency Proposed Approval of the Snake River Hells Canyon Site Specific Temperature Criterion, Hells Canyon Subbasin, HUC 17060101, Idaho and Adams Counties, Idaho (One Project)

Dear Ms. Shaw:

On April 4, 2019, NOAA's National Marine Fisheries Service (NMFS) received your request to initiate formal consultation for the U.S. Environmental Protection Agency (EPA) proposed approval of the Snake River Hells Canyon site specific temperature criterion pursuant to section 7 of the Endangered Species Act of 1973 (ESA) (16 U.S.C. 1531 et seq.). Your submittal included a final biological evaluation (BE) that analyzed the effects of the proposed action on Snake River fall and spring/summer Chinook salmon (*Oncorhynchus mykiss*), Snake River Basin steelhead (*O. mykiss*), Snake River sockeye salmon (*O. nerka*), Southern Resident killer whale (SRKW) (*Orcinus orca*), and designated critical habitat for all of these species. You also requested consultation pursuant to the essential fish habitat (EFH) provisions in section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA)(16 U.S.C. 1855(b)) for this action. In response to a request for clarification of information in the BE from NMFS, the EPA provided additional information on April 25, 2019, which serves as the initiation date of formal consultation.

In this biological opinion (Opinion), NMFS concludes that the action, as proposed, is not likely to jeopardize the continued existence of Snake River fall Chinook salmon. NMFS also determined the action will not destroy or adversely modify designated critical habitat for Snake River fall Chinook salmon. NMFS concurs with EPA's determination that the action is not likely to adversely affect Snake River spring/summer Chinook salmon, Snake River sockeye salmon, Snake River Basin steelhead, and their designated critical habitats. In the BE, EPA determined that the proposed action is likely to adversely affect SRKW and their designated critical habitat; however, EPA stated that they were not able to quantify the proposed actions impacts on Snake River fall Chinook adults present in the ocean. Instead, EPA applied a conservative precautionary principle and concluded that the determination for SRKW and their designated critical habitat should be equivalent to those for Snake River fall Chinook salmon and its designated critical habitat. After evaluating the impact of the proposed action on returning adult Snake River fall Chinook salmon, NMFS has concluded that proposed action is not likely to adversely affect SRKW and its designated critical habitat. The attached Opinion includes rationale for our conclusions summarized above.

As required by section 7 of the ESA, NMFS provides an incidental take statement (ITS) with the Opinion. The ITS describes reasonable and prudent measures (RPM) NMFS considers necessary or appropriate to minimize the impact of incidental take associated with this action. The take statement sets forth nondiscretionary terms and conditions, including reporting requirements, that the EPA, and any applicant or permittee who implements any portion of the action, must comply with to carry out the RPM. Incidental take of Snake River fall Chinook salmon associated with the proposed action will be exempt from the ESA take prohibition as long as these terms and conditions are complied with.

This document also includes the results of our analysis of the action's effects on essential fish habitat (EFH) pursuant to section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA), and includes six Conservation Recommendations to avoid, minimize, or otherwise offset potential adverse effects on EFH. These Conservation Recommendations are a non-identical set of the ESA Terms and Conditions. Section 305(b)(4)(B) of the MSA requires federal agencies provide a detailed written response to NMFS within 30 days after receiving these recommendations.

If the response is inconsistent with the EFH Conservation Recommendations, the EPA must explain why the recommendations will not be followed, including the justification for any disagreements over the effects of the action and the recommendations. In response to increased oversight of overall EFH program effectiveness by the Office of Management and Budget, NMFS established a quarterly reporting requirement to determine how many Conservation Recommendations are provided as part of each EFH consultation and how many are adopted by the action agency. Therefore, in your statutory reply to the EFH portion of this consultation, NMFS asks that you clearly identify the number of Conservation Recommendations accepted. Please contact Johnna Sandow, Boise NMFS, 208-378-5737, johnna.sandow@noaa.gov, if you have any questions concerning this consultation, or if you require additional information.

Sincerely,

Michael P. Tehan

Michael P. Tehan
Assistant Regional Administrator
Interior Columbia Basin Office

Enclosure

cc: M. A. Nelson – IDEQ
K. Hendricks – USFWS
M. Lopez – NPT
C. Colter – SBT
J. Seo – SPT
S. Crutcher – SPT

bcc: SBAO – File copy; Read File; J. Sandow; J. Thomson; R. Graves

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Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response

Snake River Hells Canyon Site Specific Temperature Criterion

NMFS Consultation Number: 2019-00175

Action Agency: U.S. Environmental Protection Agency, Region 10

Affected Species and NMFS' Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species?	Is Action Likely To Jeopardize the Species?	Is Action Likely to Adversely Affect Critical Habitat?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
Snake River Basin steelhead (*Oncorhynchus mykiss*)	Threatened	No	N/A	No	N/A
Snake River spring/summer Chinook salmon (*O. tshawytscha*)	Threatened	No	N/A	No	N/A
Snake River fall Chinook salmon (*O. tshawytscha*)	Threatened	Yes	No	Yes	No
Snake River sockeye salmon (*O. nerka*)	Threatened	No	N/A	No	N/A
Southern Resident Killer Whale (*Orcinus orca*)	Threatened	No	N/A	No	N/A

Fishery Management Plan That Identifies EFH in the Project Area	Does Action Have an Adverse Effect on EFH?	Are EFH Conservation Recommendations Provided?
Pacific Coast Salmon	Yes	Yes

Consultation Conducted By: National Marine Fisheries Service, West Coast Region

Issued By:

Michael P. Tehan
Assistant Regional Administrator

Date: September 25, 2019

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ACRONYMS

ACRONYM	DEFINITION
7DADM	7-Day Average Daily Maximum (temperature)
BE	Biological Evaluation
CWA	Clean Water Act
CWR	Cold Water Refugia
DMT	Daily Maximum Temperature
DNA	Deoxyribonucleic acid
DPS	Distinct Population Segment
DQA	Data Quality Act
EFH	Essential Fish Habitat
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
ESPA	Eastern Snake Plain Aquifer
ESU	Evolutionarily Significant Unit
FERC	Federal Energy Regulatory Commission
HCC	Hells Canyon Complex
HUC	Hydrologic Unit Code
ICTRT	Interior Columbia Basin Technical Recovery Team
IDAPA	Idaho Administration Procedures Act
IDEQ	Idaho Department of Environmental Quality
IPC	Idaho Power Company
ISG	Independent Scientific Group
ITS	Incidental Take Statement
LGD	Lower Granite Dam
MDAT	Maximum Daily Average Temperature
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MWMT	Maximum Weekly Maximum Temperature
NMFS	National Marine Fisheries Service
NPEA	Natural Production Emphasis Area
NPMP	Northern Pikeminnow Management Program
NPT	Nez Perce Tribe
NPTH	Nez Perce Tribal Hatchery
NWFSC	Northwest Fisheries Science Center
O.	*Oncorhynchus*
ODEQ	Oregon Department of Environmental Quality
Opinion	Biological Opinion
PBF	Physical or biological feature
PCE	Primary Constituent Element

ACRONYM	DEFINITION
PPA	Performance Partnership Agreement
RM	River Mile
RPM	Reasonable and Prudent Measure
SBT	Shoshone-Bannock Tribes
SPT	Shoshone-Paiute Tribes
SRKW	Southern Resident Killer Whale
SRSP	Snake River Stewardship Program
SSC	Site Specific Criteria
TDG	Total Dissolved Gas
TMCP	Temperature Management and Compliance Plan
TMDLs	Total Maximum Daily Loads
USFWS	U.S. Fish and Wildlife Service
USFS	U.S. Forest Service
USGS	U.S. Geological Survey
WMT	Weekly Maximum Temperature
WQS	Water Quality Standards

1. INTRODUCTION

This Introduction section provides information relevant to the other sections of this document and is incorporated by reference into Sections 2 and 3 below.

1.1 Background

The National Marine Fisheries Service (NMFS) prepared the biological opinion (Opinion) and incidental take statement (ITS) portions of this document in accordance with section 7(b) of the Endangered Species Act (ESA) of 1973 (16 U.S.C. 1531 et seq.), and implementing regulations at 50 CFR 402. Updates to the regulations governing interagency consultation (50 CFR part 402) will become effective on September 26, 2019 [84 FR 44976]. Because this consultation was pending and will be completed prior to that time, we are applying the previous regulations to the consultation. However, as the preamble to the final rule adopting the new regulations noted, "[t]his final rule does not lower or raise the bar on section 7 consultations, and it does not alter what is required or analyzed during a consultation. Instead, it improves clarity and consistency, streamlines consultations, and codifies existing practice." Thus, the updated regulations would not be expected to alter our analysis.

We also completed an essential fish habitat (EFH) consultation on the proposed action, in accordance with section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. 1801 et seq.) and implementing regulations at 50 CFR 600.

We completed pre-dissemination review of this document using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (DQA) (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). A complete record of this consultation is on file at the Snake Basin Office, in Boise, Idaho.

1.2 Consultation History

At the request of the Idaho Power Company (IPC), the State of Idaho adopted a site-specific temperature criterion for the Snake River, between Hells Canyon Dam and the Salmon River confluence (hereinafter referred to as the site-specific criterion [SSC]), in its water quality standards (WQS). The SSC was approved by the 2012 Idaho Legislature and became effective under Idaho law on March 29, 2019. The Idaho Department of Environmental Quality (IDEQ) submitted the SSC to the U.S. Environmental Protection Agency (EPA) for review and approval on June 8, 2012. In the fall of 2018, the EPA informed NMFS of their intention to approve the SSC.

On November 27, 2018, the EPA hosted a conference call with NMFS to introduce the proposed action, discuss the consultation schedule, and identify the best available information. The IDEQ submitted a letter to the EPA on December 7, 2019, requesting recognition as an "applicant" for the purposes of consultation under the ESA. The EPA granted applicant status to the IDEQ on December 19, 2018.

Between November of 2018 and April of 2019, NMFS and EPA participated in a number of conference calls to discuss the SSC and its potential effects on ESA-listed species and designated critical habitat under NMFS' jurisdiction. Noteworthy meetings and correspondence pertinent to this consultation are listed below.

- December 7, 2018: EPA submitted a letter requesting confirmation of the list of species and designated critical habitats protected under the ESA that may be affected by the proposed action. NMFS responded to this request via email on December 20, 2018, confirming the provided list accurately captures species and critical habitat under NMFS' jurisdiction.

- December 17, 2018: NMFS provided EPA with a PowerPoint presentation containing fall Chinook spawn survey results and stream temperature data for the Hanford Reach of the Columbia River between 2004 and 2017.

- February 8, 2019: NMFS submitted a memorandum to EPA summarizing Hanford Reach fall Chinook spawning counts and associated temperature data (Ritchie Graves, NMFS, letter sent to Dan Opalski, Director, EPA Region 10, February 8, 2019, regarding Hanford Reach fall Chinook spawning counts and associated temperature data).

- March 12, 2019: EPA shared a draft Biological Evaluation (BE) with NMFS and requested comments. NMFS provided comments on March 22, 2019.

- April 4, 2019: EPA requested initiation of formal consultation with NMFS under Section 7 (a)(2) of the ESA. Their submittal included a final BE that provided a description of the proposed action and its potential effects on the following ESA-listed species and designated critical habitats: Snake River fall Chinook salmon and Snake River spring/summer Chinook salmon (*Oncorhynchus tshawytscha*), Snake River sockeye salmon (*O. nerka*), Snake River Basin steelhead (*O. mykiss*), Southern Resident killer whale (SRKW) (*Orcinus orca*), and designated critical habitat for all five species. In addition, the BE contained an analysis of potential effects on Chinook salmon EFH.

- April 24, 2019: NMFS requested that EPA clarify their determination of effects to SRKW designated critical habitat. In addition, NMFS informed EPA that the BE included discrepancies regarding the action area and that NMFS would likely extend the action area farther downstream. Due to the expanded action area, NMFS would also include coho salmon EFH in the MSA consultation.

- April 25, 2019: EPA clarified their effects determination for SRKW designated critical habitat on April 25, 2019.

- May 3, 2019: NMFS informed the EPA that their submittal was sufficient to initiate consultation and that the initiation date of formal consultation was April 25, 2019.

In preparing this Opinion, NMFS relied on information from: (1) The final ESA Recovery Plan for Snake River Fall Chinook Salmon (NMFS 2017a); (2) temperature and redd data from the Idaho Power Company (Chandler 2019; Myers 2019); (3) Hanford Reach fall Chinook spawning counts and associated temperature data; and (4) various peer-review articles and government agency documents, cited throughout this Opinion.

A copy of the proposed action and terms and conditions section of the draft Opinion were provided to the EPA (EPA also shared the excerpts with the IDEQ) on August 29, 2019, and to the Nez Perce Tribe (NPT), Shoshone Bannock Tribes (SBT), and Shoshone Paiute Tribes (SPT) on August 30, 2019. NMFS did not receive comments from the SPT or SBT. On September 10, 2019, NMFS received comments from the EPA, which reflected input from the IDEQ. NMFS discussed these comments with the EPA and IDEQ during a conference call on September 11, 2019. NMFS subsequently modified the ITS terms and conditions to accurately reflect the authorities of the action agency and applicant.

The NPT requested additional information on August 30, 2019, and NMFS coordinated a conference call, which occurred on September 18, 2019. During the conference call with the NPT, NMFS described the effects analysis for the proposed action. This was followed by a discussion of comments and concerns that the NPT had regarding the proposed action and the effects analysis. As a result of this conversation, NMFS made minor modifications to information contained in the Opinion and ensured our effects analysis was consistent with recent management decisions.

A complete record of this consultation is on file at the Snake Basin Office in Boise, Idaho.

1.3 Proposed Federal Action

"Action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by federal agencies (50 CFR 402.02). For EFH, a federal action means any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken by a federal agency (50 CFR 600.910). "Interrelated actions" are those that are part of a larger action and depend on the larger action for their justification. "Interdependent actions" are those that have no independent utility apart from the action under consideration (50 CFR 402.02).

The Clean Water Act (CWA) requires all states to adopt WQS to restore and maintain the physical, chemical, and biological integrity of the Nation's waters (33 U.S.C. §§ 1251 et seq.). At a minimum, state WQS must include beneficial use designations (e.g., cold water aquatic life, salmonid spawning, recreation, etc.), narrative and numeric criteria to protect beneficial uses, and an antidegradation policy. Numeric water quality criteria establish levels of individual pollutants (e.g., metals, organic pollutants, chlorine, ammonia, etc.) or parameters (e.g., dissolved oxygen, temperature, dissolved gas, etc.) that will protect the designated use of the waterbody. Any water quality standards adopted or revised after May 30, 2000, must be approved by EPA before being used as the basis for any CWA-related actions. Once approved by EPA, a water quality standard is considered "effective for CWA purposes." The WQS are implemented through various regulatory programs under the CWA, including permitting of point source discharges (Section 402), permitting of discharges of dredge and fill material (Section 404), issuing water quality certifications (Section 401), and developing and implementing total maximum daily loads (Section 303(d)).

The proposed federal action subject to this consultation is EPA's proposed approval of Idaho's adoption of a site-specific temperature criterion that is applicable to the segment of the Snake River extending from Hells Canyon Dam, downstream to the Salmon River confluence. The criterion, quoted below, is stated in section 286 of the Idaho WQS (IDAPA 58.01.02).

> *"Weekly maximum temperatures (WMT) are regulated to protect fall Chinook spawning and incubation in the Snake River from Hell's [sic] Canyon Dam to the*

confluence with the Salmon River from October 23 through April 15. Because the WMT is a lagged seven (7) day average, the first WMT is not applicable until the seventh day of this time-period, or October 29. A WMT is calculated for each day after October 29 based upon the daily maximum temperature for that day and the prior six (6) days. From October 29 through November 6, the WMT must not exceed fourteen point five degrees C (14.5°C). From November 7 through April 15, the WMT must not exceed thirteen degrees C (13°C)."

For purposes of this consultation, the weekly maximum temperature (WMT) is equivalent to the 7-day average of the daily maximum temperatures (7DADM). The EPA noted several key changes between the proposed SSC and the criterion that is effective for CWA purposes. Those changes are as follows:

1. The addition of "weekly maximum temperatures (WMT) are regulated" in place of "A maximum weekly maximum temperature [MWMT]…to protect."

2. Increases the magnitude of the criterion to a WMT of 14.5°C instead of a MWMT of 13°C for the October 23 to November 6 time period.

3. Clarifies the criterion is lagged, such that the numeric criterion applies on October 29 as a result of averaging maximum daily temperatures from October 23 through October 29.

NMFS did not identify any interrelated or interdependent activities associated with this proposed action. We considered whether activities associated with the Hells Canyon Dam relicensing effort were interrelated/interdependent to this proposed action. NMFS determined that those activities were not interrelated/interdependent because the license would need to comply with all WQS that are effective for CWA purposes. Since the relicensing effort and associated activities can occur regardless of whether this SSC is approved, those activities are not considered interrelated/interdependent.

2. ENDANGERED SPECIES ACT: BIOLOGICAL OPINION AND INCIDENTAL TAKE STATEMENT

The ESA establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat upon which they depend. As required by section 7(a)(2) of the ESA, each federal agency must ensure that its actions are not likely to jeopardize the continued existence of endangered or threatened species, or adversely modify or destroy their designated critical habitat. Per the requirements of the ESA, federal action agencies consult with NMFS and section 7(b)(3) requires that, at the conclusion of consultation, NMFS provides an Opinion stating how the agency's actions would affect listed species and their critical habitats. If incidental take is reasonably certain to occur, section 7(b)(4) requires NMFS to provide an ITS that specifies the impact of any incidental taking and includes non-discretionary reasonable and prudent measures (RPMs) and terms and conditions to minimize such impacts.

The EPA determined the proposed action is not likely to adversely affect Snake River spring/summer Chinook salmon, Snake River Basin steelhead, and Snake River sockeye salmon or their designated critical habitats. Our concurrence is documented in the "Not Likely to

Adversely Affect" Determinations section (Section 2.12). The EPA also concluded that the proposed action was likely to adversely affect SRKW and its designated critical habitat. NMFS does not concur with this determination. Based on the best available science, NMFS has concluded the proposed action is not likely to adversely affect SRKW and its designated critical habitat. Our rationale for this conclusion is provided in Section 2.12.

2.1 Analytical Approach

This Opinion includes both a jeopardy analysis and/or an adverse modification analysis. The jeopardy analysis relies upon the regulatory definition of "to jeopardize the continued existence of" a listed species, which is "to engage in an action that would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR 402.02). Therefore, the jeopardy analysis considers both survival and recovery of the species.

This Opinion relies on the definition of "destruction or adverse modification," which "means a direct or indirect alteration that appreciably diminishes the value of critical habitat for the conservation of a listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features essential to the conservation of a species or that preclude or significantly delay development of such features" (81 FR 7214).

The designation of critical habitat for Snake River fall Chinook salmon (58 FR 68543) uses the term primary constituent elements (PCEs). The new critical habitat regulations (81 FR 7414) replace this term with physical or biological features (PBFs). The shift in terminology does not change the approach used in conducting a ''destruction or adverse modification'' analysis, which is the same regardless of whether the original designation identified PCEs or PBFs. In this Opinion, we use the term PBF to mean PCE.

We use the following approach to determine whether a proposed action is likely to jeopardize listed species or destroy or adversely modify critical habitat:

- Identify the rangewide status of the species and critical habitat expected to be adversely affected by the proposed action.

- Describe the environmental baseline in the action area.

- Analyze the effects of the proposed action on both species and their habitat using an "exposure-response-risk" approach.

- Describe any cumulative effects in the action area.

- Integrate and synthesize the above factors by: (1) Reviewing the status of the species and critical habitat; and (2) adding the effects of the action, the environmental baseline, and cumulative effects to assess the risk that the proposed action poses to species and critical habitat.

- Reach a conclusion about whether species are jeopardized or critical habitat is adversely modified.

- If necessary, suggest a reasonable and prudent alternatives to the proposed action.

2.2 Rangewide Status of the Species and Critical Habitat

This Opinion examines the status of each species that would be adversely affected by the proposed action. The status is determined by the level of extinction risk that the listed species face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. This informs the description of the species' likelihood of both survival and recovery. The species status section also helps to inform the description of the species' current "reproduction, numbers, or distribution" as described in 50 CFR 402.02. This Opinion also examines the condition of critical habitat throughout the designated area, evaluates the conservation value of the various watersheds that make up the designated area, and discusses the current function of the essential PBF that help to form that conservation value. Table 1 summarizes the most recent regulations pertaining to Snake River fall Chinook salmon.

Table 1. Listing status, status of critical habitat designations and protective regulations, and relevant Federal Register decision notices for ESA-listed species considered in this Opinion.

Species	Listing Status	Critical Habitat	Protective Regulations
Chinook salmon *(Oncorhynchus tshawytscha)*			
Snake River fall-run	T 6/28/05; 70 FR 37160	12/28/93; 58 FR 68543	6/28/05; 70 FR 37160

Note: Listing status: 'T' means listed as threatened under the ESA.

2.2.1 Status of Snake River Fall Chinook Salmon

Snake River fall Chinook salmon were originally listed as threatened in 1992 (57 FR 14653), and their status was affirmed in 2005 (70 FR 37160). Snake River fall Chinook salmon have substantially declined in abundance from historic levels, due to many factors including:

1. The development of mainstem dams in the middle Snake River from the 1900s to the 1960s (e.g., Swan Falls Dam, the Hells Canyon Complex (HCC) of dams, and others) inundated and blocked access to the most productive spawning and rearing habitat. This, in turn, eliminated one of the two large populations that are thought to have contributed to the historical structure of this evolutionarily significant unit (ESU). The construction of Lewiston Dam on the Clearwater River blocked access to habitat upstream of river mile (RM) 6 starting in 1927, extirpating fall Chinook salmon within that subbasin.

2. The dam operations (and additionally, water storage, irrigation and hydropower projects throughout the Columbia River basin) have substantially affected seasonal flows (by increasing November to March flows and decreasing May to July flows in the mainstem Snake and Columbia Rivers) as well as water quality within and downstream of the dams (altered seasonal thermal regime, elevated total dissolved gas (TDG) levels in the winter and spring, lowered dissolved oxygen levels in the late summer and fall, etc.).

3. The development of mainstem dams in the lower Snake and Columbia Rivers (1938 to 1975) greatly altered mainstem migration and rearing habitat and substantially impacted the survival of juvenile migrants. The dams likely impacted the survival of migrating adults as well, at least in some years.

4. Chinook salmon were harvested at very high rates starting in the 1880s, and relatively high aggregate (ocean and in-river) harvest continued at high levels through the 1980s (Good et al. 2005).

5. Land use practices (agriculture, grazing, mining, timber harvest, etc.) throughout the basin negatively affected important water-quality parameters (nutrients, fine sediments, toxic contaminants) and channel complexity, habitat quantity and diversity, especially in the middle Snake River and the lower reaches of the five Snake River tributaries used for spawning and rearing (Good et al. 2005).

These factors substantially reduced the amount and quality of available spawning, rearing, and migration corridor habitat; reduced the productivity of Snake River fall-run Chinook salmon in all freshwater life history stages; and resulted in extremely low abundance by 1990, when only 78 naturally produced adults were counted passing Lower Granite Dam (LGD).

Historically, Snake River fall Chinook salmon inhabited a geographically large and complex area extending from the Pacific Ocean into a large portion of the Snake River basin (Figure 1). Currently, this ESU is restricted to below the Hells Canyon Dam and includes one extant population of fish with five major spawning areas (Table 2). Fall-run Chinook salmon from four artificial propagation programs are included in this ESU: Lyons Ferry Hatchery Program, Fall Chinook Acclimation Ponds Program, Nez Perce Tribal Hatchery (NPTH) Program, and Oxbow Hatchery Program (70 FR 37160)

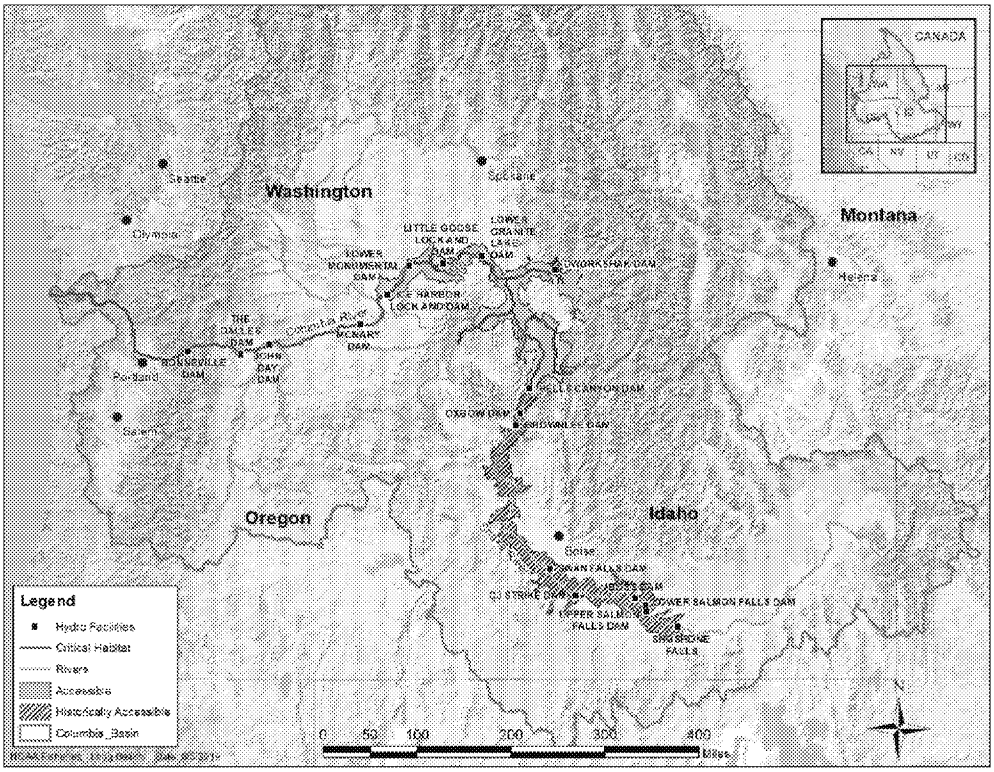


Figure 1. Snake River fall Chinook salmon ESU–current and historical range and critical habitat.

Table 2. Descriptions of the five major spawning areas for Snake River fall Chinook salmon (NMFS 2017a).

Major Spawning Area	Description
Upper Hells Canyon	This area includes the mainstem Snake River extending about 60 miles from Hells Canyon Dam downstream to the Salmon River confluence. The area also includes spawning in the lower Imnaha and Salmon Rivers.
Lower Hells Canyon	This area includes the mainstem Snake River extending about 43 miles from the Salmon River confluence to the upper end of the contemporary LGD pool. The area also includes spawning in the Alpowa and Asotin Creeks.
Clearwater River	This area includes the lower mainsteam Clearwater River. Historical evidence suggests that the Selway River and other tributaries also supported spawning.
Grande Ronde River	This area includes the lower Grande Ronde River. Spawning may also have occurred in some tributaries to the Grande Ronde River.
Tucannon River	This area includes the lower Tucannon River and the adjacent inundated mainstem Snake River associated with Little Goose and Lower Monumental Dams.

General threats to Snake River fall Chinook salmon include hydropower; harvest; hatcheries; ecological interactions (e.g., predation and competition); and land uses that contribute toxic pollutants. The recovery plan (NMFS 2017a) provides detailed information about of each of these threat categories and the associated limiting factors that these threats cause or contribute to. The following sections summarize the life history, hatcheries, harvest, current status of the species, and recovery plan for this ESU. More detailed information on these topics can be found in the recovery plan (NMFS 2017a) and most recent status review (NMFS 2016a; NWFSC 2015) for this species. These documents are available on the NMFS West Coast Region website.

2.2.1.1 Life History

Most Snake River fall Chinook salmon production historically came from large mainstem reaches that supported a subyearling, or "ocean-type," life history strategy. Adults enter the Columbia River in July and August, and migrate past the lower Snake River mainstem dams from August through November. Fish spawning takes place from October through early December in the mainstem of the Snake River, primarily between Asotin Creek and Hells Canyon Dam, and in the lower reaches of several of the associated major tributaries including the Tucannon, Grande Ronde, Clearwater, Salmon, and Imnaha Rivers (Connor and Burge 2003; Ford 2011). Spawning has occasionally been observed in the tailrace areas of the four mainstem dams (Dauble et al. 1999). Juveniles emerge from the gravels in March and April of the following year.

Ocean-type or subyearling Chinook salmon juveniles tend to display a "rear as they go" rearing strategy in which they continually move downstream through shallow shoreline habitats their first summer and fall until reach the ocean by winter (Connor and Burge 2003; Coutant and Whitney 2006). At present, the subyearling life history strategy contributes most of the natural-origin adult returns to the ESU, and the timing of adult migration and spawning plus egg incubation, fry emergence, and juvenile emigration is similar to historical patterns. However, a yearling life history strategy is also supported, mostly for juveniles from the cooler Clearwater River subbasin, which overwinter in the lower Snake River reservoirs or other cool-water refuge areas and migrate downstream the following spring (NMFS 2017a). These fish begin migration later than most, arrest their seaward migration and overwinter in reservoirs on the Snake and Columbia Rivers, then resume migration and enter the ocean in early spring as age-1 smolts (Connor and Burge 2003; Connor et al. 2002; Connor et al. 2005; Hegg et al. 2013). Connor et al. (2005) termed this life history strategy "reservoir-type."

2.2.1.2 Hatcheries

The Snake River fall Chinook salmon ESU currently includes four hatchery programs: the Lyons Ferry Hatchery, the Fall Chinook Acclimation Project, the NPTH, and the IPC programs (70 FR 37160). All four programs are funded as mitigation for fish production lost through construction and operation of hydropower dams in the Columbia and Snake River basins. Releases of hatchery fish from these programs all provide fish for harvest, but some releases are also intended to return hatchery fish to spawn naturally to increase the abundance of the naturally spawning population.

The hatchery effort has grown in size and complexity. The initial focus was to provide fish for harvest as well as to help maintain/rebuild returns of Snake River fall Chinook salmon to mitigate for losses caused by construction and operation of the four lower Snake River dams (assuming the mitigation program premise that approximately 52 percent of the Snake River salmon runs would be naturally produced [NPCC 2008]). Initially, juvenile hatchery fish were released only at the Lyons Ferry Hatchery, which is well below most of the area available for natural spawning (and below the action area for the proposed action). The intent of this phase of the Lyons Ferry Hatchery program was to increase hatchery releases, adult returns, and broodstock availability to levels sufficient to support releases upstream of LGD. However, return rates of hatchery-released fall Chinook salmon declined in the early 1990s (Bugert et al. 1997), and hatchery broodstock collections were compromised (particularly in 1989) by out-of-basin hatchery strays, mostly from the Umatilla program (Hayes and Carmichael 2002), which resulted in a substantial decrease in hatchery releases for several years as well as a serious threat to the genetic integrity of the species (Waples et al. 1993; NMFS 2016a, NMFS 2017a).

Over time, the hatchery effort has become focused more on supplementation, with an increasing proportion of fish released above LGD; 80 percent of the hatchery fish are now released above LGD. A major change in this direction of supplementation was the 1995 implementation of the Fall Chinook Acclimation Project, which involves releases at sites on the Snake and the Clearwater Rivers at facilities operated by the NPT. Coincident with these increased supplementation releases, added releases of fish intended for harvest have also occurred. The IPC program, which releases approximately 1 million fish near Hells Canyon Dam, began in 2000. The program started as a result of the 1980 Settlement Agreement for loss of production of anadromous fish as a result of construction and operation of the HCC.

These hatchery supplementation efforts have definitely increased spawning redd production in the two Hells Canyon reaches and the Clearwater River. Based on total spawning redd counts for the ESU made between 2000 and 2018 (Arnsberg et al. 2019, 2018, 2017, 2016, 2015, 2014, 2013, 2012, and 2011; Garcia et al. 2010), the proportion of redds laid in the mainstem Snake River relative to the entire ESU has ranged from 31 percent (2016) to 74.9 percent (2006). During that same time, the percentage of total ESU redd construction happening in the Clearwater basin has ranged between 18.8 percent (2006) and 58.1 percent (2016) (Arnsberg et al. 2019, 2018, 2017, 2016, 2015, 2014, 2013, 2012, and 2011; Garcia et al. 2010). Over the past 10 years, there has been a minor increase in the percentage of total ESU redds coming from the notably cooler, Clearwater River, and also a slight, decreasing trend in the Lower and Upper Hells Canyon areas (combined). However, as noted above, a high proportion of the redds found in both the Hells Canyon reaches and the Clearwater Basin are constructed by returning hatchery fish, and so the increase in redd contributions observed in the Clearwater during this time may be a result of a larger proportion of hatchery fish being released into the Clearwater and a smaller proportion into the Hells Canyon reaches (compared to recent 20-year averages: 2000–2019) (FPC 2019).

Production goals, release sizes, release locations, release priorities, life stage at release (yearling or subyearling), and marking/tagging rates of released fish for all four Snake River fall Chinook salmon hatchery programs are established through the *U.S. v. Oregon* management process. Table 3 summarizes the overall releases that have occurred in the Snake River basin (NMFS 2018a).

Table 3. Snake River Fall Chinook Hatchery Production Facilities, Release Locations, and Production Goals Under the Most Recent *U.S. v. Oregon* Management Agreements.

Production Facility	Release Location	2008-2017		2018-2027	
		Production Goal[1]	Age of Release	Production Goal[1]	Age of Release
Lyon's Ferry Hatchery	Pittsburg Landing	150	1+	400	0+
		200	0+	200	0+
		200	0+		
	Captain John's Rapids	150	1+	450	0+
		500	0+	200	0+
		200	0+		
	Lyon's Hatchery, direct release	450	1+	500	0+
		200	0+	450	1+
				200	0+
	Big Canyon	150	1+	450	0+
		500	0+	200	0+
Irrigon Hatchery	Salmon River	200	0+		
		200	0+	1000	0+
		600	0+		
	Grande Ronde	200	0+	200	0+
		200	0+		
Nez Perce Tribal Hatchery	NPTH, direct release	500	0+	500	0+
	Luke's Gulch	200	0+	350	0+
	Cedar Flats	200	0+	350	0+
	North Lapwai Valley	500	0+	200	0+
TOTALS					
	Total Releases in Action Area	**1,400**		1,250	
	Action Area and Above	**2,800**		2,450	
	Below Action Area (Mainstem Snake)	650		**1,150**	
	Clearwater Basin (NPTH and Others)	2,050		2,050	
	GRAND TOTAL TO SNAKE RIVER BASIN	**5,500**		**5,650**	

[1]Numbers are in thousands.

Several major uncertainties exist regarding the effects of hatchery programs on natural-origin populations. These uncertainties include a limited understanding of the impact of hatchery releases on natural-origin population abundance, productivity, and genetic integrity, as well as the effects of ecological interactions between hatchery and natural-origin ESA-listed fish in the tributary and mainstem environment (competition and predation effects, disease effects, genetic effects, and broodstock collection and facility effects). Hatchery practices have evolved as the status of natural populations has changed and as new plans have been implemented and evaluated (via recent ESA consultations on Hatchery Genetic Management Plans). In 2018

NMFS completed a biological opinion aimed at comprehensively assessing hatchery benefits and risks across the Snake River basin, which has resulted in operational refinements and changes that are expected to benefit listed species (NMFS 2018b).

2.2.1.3 Harvest

Snake River fall Chinook salmon encounter fisheries in the ocean from Alaska to California, and in the mainstem Columbia River and some tributaries. These fisheries do not directly target ESA-listed natural-origin fall Chinook salmon. Instead they target marked hatchery fish (fall Chinook salmon and other species) and non-listed natural fish (fall Chinook salmon and other species). These fisheries are managed to limit impacts on natural-origin Snake River fall Chinook salmon and other ESA-listed species, while optimizing harvest of healthier stocks to the extent possible within constraining limits for weak stocks (NMFS 2017a). Historically, Snake River fall Chinook salmon were subject to total exploitation rates approaching 80 percent. Since ESA listing, harvest impacts in both ocean and in-river fisheries have been reduced. The total exploitation rate has been relatively stable at 40 to 50 percent since the mid-1990s (Ford et al. 2011); and up to half of this exploitation can occur in Columbia River fisheries (Figure 2).

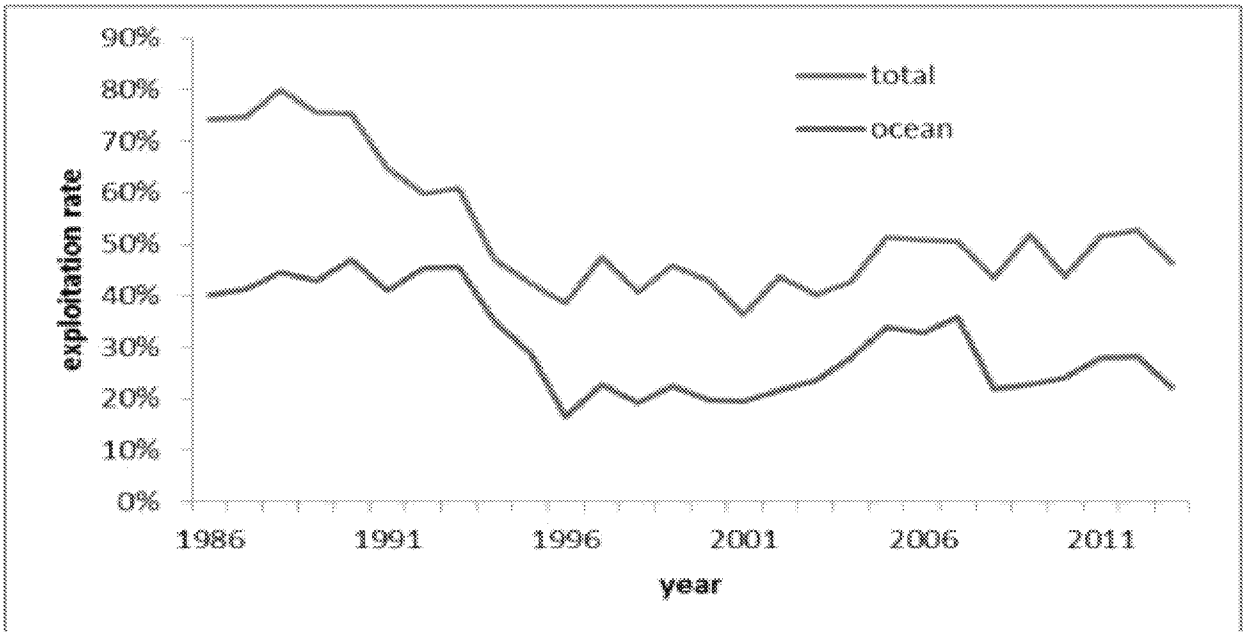


Figure 2. Total exploitation rates for Snake River fall Chinook salmon over time (NMFS 2017a).

In February 2018, NMFS signed the 2018–27 *U.S. v Oregon* Management Agreement, which provides the current framework for managing fisheries and hatchery programs in much of the Columbia River Basin. The Management Agreement accomplishes two primary objectives. First, it implements harvest policies that the parties[1] have agreed should govern the amount of harvest. Second, it incorporates hatchery programs that provide harvest opportunities and that are important to the conservation of salmon and steelhead runs above Bonneville Dam. NMFS' decision to sign the Management Agreement took into account the recently completed Final

[1] The Nez Perce, Umatilla, Warm Springs, Yakama, and Shoshone-Bannock Tribes; the states of Washington, Idaho, and Oregon; and NMFS, the U.S. Fish and Wildlife Service (USFWS), and the Bureau of Indian Affairs are signatories of the Management Agreement.

Environmental Impact Statement and the associated biological opinion (NMFS 2018a). As a result, fisheries affecting Snake River fall Chinook in the 2018–27 *U.S. v Oregon* Management Agreement are aligned with the recovery plan strategies in the recovery plan.

Harvest within the Snake River basin has been minimal relative to that which occurs in the Pacific Ocean and mainstem Columbia River. Fall Chinook salmon fisheries in the Snake River basin typically take place from August through November. The non-tribal fisheries here have selectively targeted hatchery fish with a clipped adipose fin in the past, while tribal fisheries have retained both hatchery- and natural-origin fish regardless of external marking. Recent harvest estimates (2010 to 2017) of both hatchery and natural-origin fall Chinook salmon in the Snake basin (calculated as a percentage of adult fish counts at LGD) have averaged about 4 percent of hatchery fall Chinook salmon and 3 percent of natural fall Chinook salmon. An additional 0–3 percent natural-origin fall Chinook salmon are likely to be incidentally killed in other fisheries, primarily steelhead, occurring throughout the Snake River basin (NMFS 2019a).

In the spring of 2019, the states of Idaho, Washington and Oregon, proposed a new fall Chinook Fishery Management & Evaluation Plan which was evaluated by the National Marine Fisheries Service. Similarly, the NPT submitted an updated a revised Tribal Resources Management Plan to NMFS for review in late 2018. Under these newly proposed harvest rate schedules, total harvest rates would range between 6 and 20 percent of all natural-origin Snake River fall Chinook salmon passing LGD (including 8 and 14 percent total harvest rates for returns between 1,261 and 5,040), which is a marked increase from current harvest rates on this recovering population (NMFS 2019a). The proposal includes efforts to distribute about 47 percent of the non-tribal harvest to areas above LGD in the mainstem Snake River as well as in the Salmon and Grande Ronde Rivers. The remaining 53 percent of the non-tribal harvest would be distributed in areas below LGD (5 percent) and in the Clearwater River (48 percent) (NMFS 2019a).

2.2.1.4 Predation

Piscivorous colonial waterbirds, especially terns, cormorants, and gulls, are having a significant impact on the survival of juvenile salmonids (including Snake River fall Chinook salmon) in the Lower Columbia River estuary. Management efforts are ongoing to further reduce salmonid consumption by terns and similar efforts are in progress to reduce the nesting population of double-crested cormorants in the estuary. Based on PIT-tag recoveries at East Sand Island, where the Rice Island tern colony was relocated beginning in 1999, average annual tern and cormorant predation rates for this ESU were about 2.5 and 3.0 percent, respectively, before efforts to manage the size of these colonies (Evans et al. 2018). The Caspian Tern and Double-crested Cormorant Management Plans, implemented by the Corps, has seen mixed results due to the dispersal of both terns and cormorants to other locations within the estuary. Average predation rates on Snake River fall Chinook salmon have decreased to 0.8 percent for terns nesting on East Sand Island, but in 2017 this improvement was offset to some unknown degree by terns roosting farther upstream on Rice Island (Evans et al. 2018). Substantial numbers of cormorants have relocated to the Astoria-Megler Bridge (preliminary report of 1,737 in 2018) and hundreds more are observed on the Longview Bridge, navigation aids, and transmission towers in the lower river (Anchor QEA et al. 2017). Smolts may constitute a larger proportion of the diet of cormorants nesting at these sites than if the birds were foraging from East Sand Island. Thus, the success of the East Sand Island tern and cormorant management plans at meeting their underlying goals of reducing salmonid predation is uncertain at this time (NMFS 2019b).

Snake River fall Chinook salmon are also vulnerable to predation by terns nesting in the interior Columbia plateau, including colonies on islands in McNary Reservoir, in the Hanford Reach, and in Potholes Reservoir (NMFS 2019b). Smolts come within foraging range of other nesting sites on the plateau (principally the Blalock Islands in John Day Reservoir) as they continue downstream.

Due to large management efforts undertaken by the Corps, including dissuasion, hazing and island revegetation, the numbers of pairs of Caspian terns nesting on the Columbia plateau in 2017 represented a 23 percent drop from the pre-management period, and predation rates by terns for Snake River fall Chinook salmon at sites on the Columbia plateau were below 2 percent in 2015–16 at each of these nesting colonies (NMFS 2019b). All Federal Columbia River Power System projects have been implementing avian control measures at the dams and are currently using several strategies that have proven to be effective at meeting this objective, including: avian arrays in tailrace areas, spike strips, outfall water sprinklers, dam-based hazing with pyrotechnics, propane cannons, and limited lethal take. Because of these efforts, avian predation on juvenile salmon and steelhead at the dams has been reduced since implementation began (Zorich et al. 2012).

California sea lions, Stellar sea lions, and harbor seals consume adult Chinook salmon from the mouth of the Columbia River and tributaries up to Bonneville Dam. A small number of California sea lions have also been observed in Bonneville Reservoir in recent years. The Oregon Department of Fish and Wildlife has been counting the number of individual California sea lions hauling out at the East Mooring Basin in Astoria, Oregon, since 1997. Pinniped counts at the mooring basin during September and October have increased from an average of 269 from 2008–14 to an average of 914 in 2015 and 2016, and many adult Snake River fall Chinook salmon are migrating through this area at that time of year (NMFS 2019b). However, Snake River fall Chinook adult salmonid losses due to pinniped predation are likely greatest directly downstream of Bonneville Dam. The dam provides a predation advantage, as fish congregate in search of ladder entrances; this can concentrate fish, making them more vulnerable to predation (Stansell 2004). Between 21 July and 31 December 2017, Tidwell et al. (2018) documented an average of 14.5 Stellar sea lions per day at Bonneville Dam. Based on predation observation during these periods, they estimate pinnipeds consumed 0.7 percent of the fall Chinook salmon run (Tidwell et al. 2018).

The native northern pikeminnow is a significant predator of juvenile salmonids in the Columbia River (reviewed in ISAB 2015). Before the start of the Northern Pikeminnow Management Program (NPMP) in 1990 this species was estimated to eat about 8 percent of the 200 million juvenile salmonids that migrated downstream in the Columbia River (including the hydrosystem reach) each year. Williams et al. (2017) compared current estimates of northern pikeminnow predation rates on juvenile salmonids to before the start of the program and estimated a median reduction of 30 percent. The NPMP consists of both a Sport Reward Fishery in the lower Columbia River estuary and throughout the hydrosystem reach, as well as a newer Dam Angling Program to remove large pikeminnow from the tailraces of The Dalles and John Day Dams. Based on diet studies associated with both of these projects, it was found that juvenile salmonids comprise 0.02 and 0.20 of total stomach contents from northern pikeminnow collected between Bonneville Dam and the estuary (with 0.07 to 0.012 of the gut contents were unidentifiable). Similarly juvenile salmonids composed 3 to 20 percent of the pikeminnow stomach contents collected via the dam angling study (Williams et al. 2017).

Non-native smallmouth bass and walleye are significant predators of juvenile salmonids in the hydrosystem reach (reviewed in Friesen and Ward 1999; ISAB 2011, 2015). In recent years, the NPMP has been conducting diet studies on a portion of the walleye and smallmouth bass that they encounter during both the pikeminnow tagging and dam angling efforts. Williams et al. (2017) observed a significant increase in the salmon consumption index for walleye caught at the dams when salmonid yearling passage was decreasing and subyearling (fall Chinook) passage was increasing. There was also a substantial increase in the walleye catch at the two dams in 2017, especially at John Day dam. These two pieces of information indicate that Snake River fall Chinook mortality due to walleye predation may be increasing in certain parts of the Columbia River.

2.2.1.5 2016 Status of the Species

In the most recent status review update, the Northwest Fisheries Science Center (NWFSC) recommended that the overall risk rating for Snake River fall Chinook salmon be reduced from moderate risk (i.e., maintained viability status) to low risk (i.e., viable). This recommended change in viability is primarily due to substantial improvements in the abundance and productivity of the ESU through 2015. While the single extant population in the ESU currently meeting the criteria for a "viable" rating, the ESU as a whole is not meeting the recovery goals described in the recovery plan for the species, which require the single population to be "highly viable with high certainty" and/or will require reintroduction of a viable population above the HCC (NWFSC 2015). Even in light of the improvement in viability, NMFS determined the species should remain listed as threatened (NMFS 2016a; 81 FR 33468).

Abundance and Productivity. Historical abundance of Snake River fall Chinook salmon is estimated to have been 416,000 to 650,000 fish (NMFS 2006), but numbers declined drastically over the 20th century. The first hatchery-reared Snake River fall Chinook salmon returned to the Snake River in 1981, and since then the number of hatchery returns has increased steadily, such that hatchery fish dominate the Snake River fall Chinook run. Natural returns have also increased. The recent 10-year (2005–2014) mean abundance of natural-origin fall Chinook is 6,148 adult spawners, above the minimum viability goal of 4,200 spawners and largely driven by relatively high numbers in 2012–2014 (NWFSC 2015, Figure 3). It is important to note that the natural-origin fall Chinook spawners include adult returns of unclipped hatchery fish that were released as juveniles above the LGD. Productivity estimated from 1990–2009 brood years is 1.5, meeting the Interior Columbia Technical Recovery Team's (ICTRT's) abundance/productivity criteria for a viable population, but falling short of the productivity of 1.7 needed for highly viable status. An increase in productivity could be generated by reductions in mortalities across life stages, such as a reduction in harvest impacts on adults, currently at 40–50 percent, or improvements in juvenile survivals during downstream migration, currently estimated to be about 70 percent for migrants between Lower Granite and McNary dams (NWFSC 2015; NMFS 2019b).

In addition, observations of coastal ocean conditions suggest that the 2015–17 outmigrant year classes experienced below-average ocean survival (NWFSC 2015, NWFSC 2017, *as cited in* NMFS 2019b). These variations in conditions affecting early ocean survival indicate that despite efforts to address key threats in freshwater, the future status of Snake River fall Chinook salmon is somewhat uncertain.

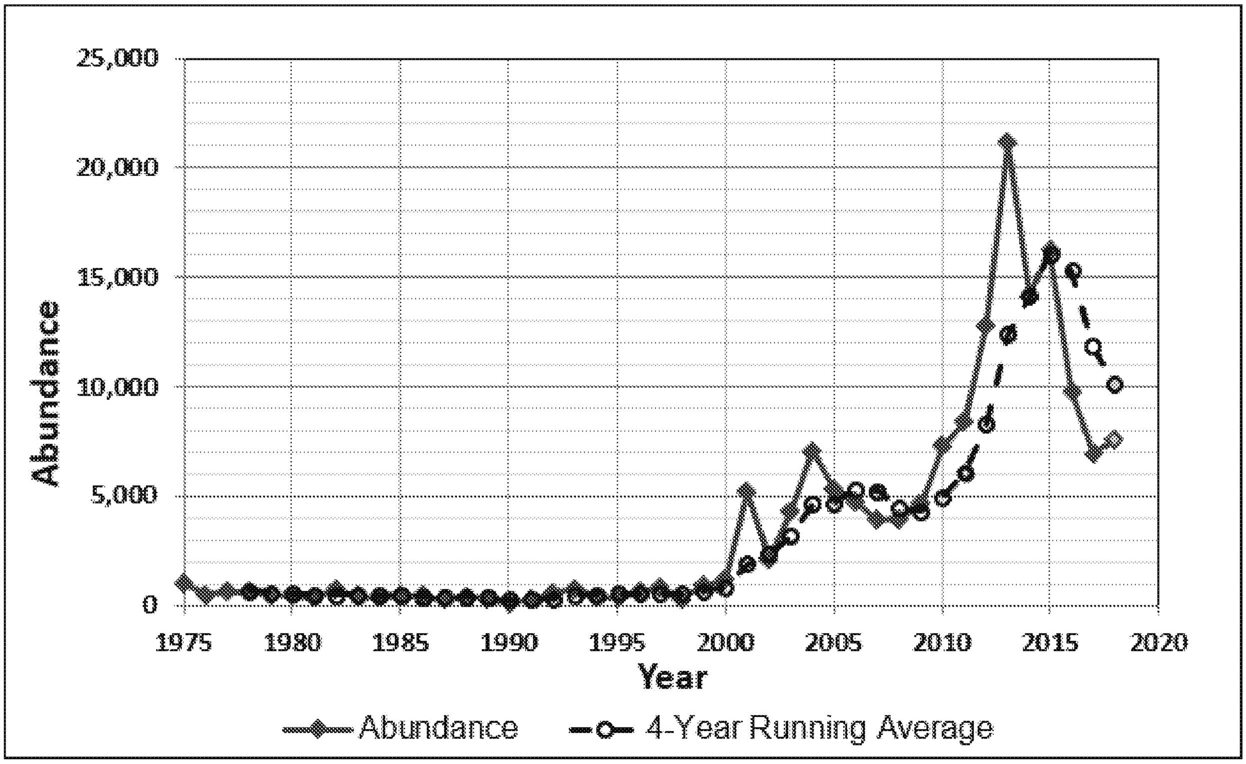


Figure 3. Estimated annual abundance (and 4-year running average abundance) of natural-origin adult Snake River fall Chinook salmon passing LGD (1975-2018).

Spatial Structure and Diversity. The NWFSC (2015) gave the ESU a rating for moderate risk for spatial structure/diversity, "driven by changes in major life history patterns, shifts in phenotypic traits, and high levels of genetic homogeneity in samples from natural-origin returns." The rating also reflected risk associated with the high levels of hatchery-origin spawners in natural spawning areas and "the potential for selective pressure imposed by current hydropower operations and cumulative harvest impacts." Between 2010 and 2014, only 31percent of spawners in the population were natural-origin, and hatchery-origin returns are widespread across the major spawning areas within the population (NWFSC 2015). Diversity risk will need to be reduced to low in order for this population to be considered highly viable, a requirement for recovery of the species. Low diversity risk would require that one or more major spawning areas produce a significant level of natural-origin spawners with low influence by hatchery-origin spawners (NWFSC 2015).

2.2.1.6 Recovery of the Species

The ESA recovery goal for this ESU is to conserve the ecosystems upon which the species depend so that the ESU is self-sustaining in the wild (NMFS 2017a). The Snake River fall Chinook salmon recovery plan (NMFS 2017a) outlines the following three potential recovery scenarios: (1) Achieve highly viable status for the extant Lower Snake River population and viable status for the currently extirpated Middle Snake River population; (2) Achieve highly viable status (with a high degree of certainty) for Lower Snake River population; and (3) Achieve highly viable status for Lower Snake River population with the creation of a Natural Production Emphasis Area (NPEA). The recovery plan identified the NPEA approach as the most likely scenario to achieve recovery, although it also recognized there are uncertainties about whether the effect of reducing hatchery-origin spawners in NPEAs will be to sustain, increase, or decrease natural production levels in these areas. Tentative targets set by NMFS for the NPEA were a proportionate natural influence level of 67 percent or more, and contributing 40 percent or more of the population's total natural production (NMFS 2017a).

The recent Proposed Action from the *U.S. v. Oregon* biological opinion (NMFS 2018a), as well as the site-specific Snake River fall Chinook hatchery consultation in 2018 (NMFS 2018b) include consideration of a phased approach to the NPEA proposal in which the hatchery operators would change one of their release locations: moving the release of 1,000,000 subyearling fall Chinook salmon from Hells Canyon Dam to a site (of equivalent distance to LGD) on the lower Salmon River. A phased approach to reduce hatchery effects was selected because of the uncertainties regarding survival rates, homing to the Salmon River, and response of natural production to a large scale change from the present configuration of hatchery releases. Implementation of the NPEA means the population is now being managed at a much higher proportionate natural influence level than it was previously. Thus, although the hatchery programs continue to pose risk, this management change is expected to reduce genetic risk to the ESU (NMFS 2018b) relative to previous management. It also potentially offers large benefits in terms of better understanding this salmon population (e.g., productivity and abundance), as well as providing critical information on the consequences of large-scale perturbations in hatchery/natural dynamics.

The recovery plan (NMFS 2017a) acknowledges that "uncertainty remains regarding the driving factors for the recent increases in fall Chinook salmon abundance and productivity, and whether those increases will persist into the future across a range of changing environmental conditions. There is also uncertainty about the long-term effects of the high proportions of hatchery-origin spawners on species productivity and diversity." The recovery plan identifies ten management strategies (with associated ongoing actions that should continue and potential additional actions that should be considered for future implementation) for recovering the Snake River fall Chinook salmon ESU. These strategies address effects across the life cycle of the species (e.g., hatchery, hydropower, freshwater and estuarine habitat, harvest, climate change, etc.) and call for research, monitoring, and evaluation to better understand the combined and relative effects of limiting factors driving the abundance and productivity of the species, reduce uncertainty about the species status, evaluate action effectiveness and call for an adaptive management approach to recovery. In addition, the plan calls for an evaluation of the feasibility of providing adult and juvenile fish passage to and from spawning and rearing areas above the HCC, and for restoring habitat conditions that can support Snake River fall Chinook salmon spawning and rearing above the HCC by encouraging local governments and stakeholders to implement actions to reduce nutrients and sediment inputs.

The recovery strategy for freshwater habitat is to maintain and improve spawning, incubation, rearing, and migration conditions by continuing ongoing actions and implement additional actions as appropriate. The recovery plan identified the following habitat limiting factors in freshwater: elevated water temperatures, degraded water quality (i.e., elevated total dissolved gas, low dissolved oxygen, toxic pollutants, excess sediment, and excess nutrients), altered hydrologic regimes, low flows, loss of spawning and rearing habitat (either through blocked access or inundation), reduced habitat complexity and floodplain connectivity, and degraded riparian conditions. Information gained through research, monitoring, and evaluation and refined through use of life-cycle models and other tools will aid our ability to weigh the relative impacts of the limiting factors and threats on the ESU's status. Prioritization of recovery actions will be geared toward achieving recovery as quickly and effectively as possible (NMFS 2017a). Actions to maintain and improve habitat in the mainstem Snake River have been, and will be, implemented primarily under consultations for the Columbia River Power System and the HCC (NMFS 2017a).

Overall, the status of Snake River fall Chinook salmon has clearly improved compared to the time of ESA listing. The single extant population in the ESU is currently meeting the criteria for a rating of "viable" developed by the ICTRT, but the ESU as a whole is not meeting the recovery goals described in the recovery plan for the species. For recovery of the species, the Lower Snake population will need an increase in estimated productivity combined with a reduction in diversity risk.

2.2.2 Status of Snake River Fall Chinook Salmon Designated Critical Habitat

Snake River fall Chinook salmon critical habitat was designated in 1993 (Table 1). Designated critical habitat includes the following freshwaters: (1) Columbia River from its mouth upstream to its confluence with the Snake River; (2) Snake River from its confluence with the Columbia River to Hells Canyon Dam; (3) Palouse River from its confluence with the Snake River upstream to Palouse Falls; (4) Clearwater River from its confluence with the Snake River upstream to Lolo Creek; (5) North Fork Clearwater River from its confluence with the Clearwater River upstream to Dworshak Dam; and (6) all other river reaches presently or historically accessible within the Lower Clearwater, Hells Canyon, Imnaha, Lower Grande Ronde, Lower Salmon, Lower Snake, Lower Snake–Asotin, Lower North Fork Clearwater, Palouse, and Lower Snake–Tucannon subbasins. Designated critical habitat consists of the water, waterway bottom, and the adjacent riparian zone (defined as an area 300 feet from the normal high water line on each side of the river channel).

In evaluating the condition of designated critical habitat, NMFS examines the condition and trends of PBFs which are essential to the conservation of the ESA-listed species because they support one or more life stages of the species. Proper function of these PBFs is necessary to support successful adult and juvenile migration, adult holding, spawning, incubation, rearing, and the growth and development of juvenile fish. Modification of PBFs may affect freshwater spawning, rearing or migration in the action area. Generally speaking, sites required to support one or more life stages of the ESA-listed species (i.e., sites for spawning, rearing, migration, and foraging) contain PBFs essential to the conservation of the listed species (e.g., spawning gravels, water quality and quantity, side channels, or food) (Table 4).

Table 4. Types of sites, essential physical and biological features, and the species life stage each PBF supports.

Site	Essential Physical and Biological Features	Species Life Stage
Snake River Fall Chinook Salmon		
Spawning & Juvenile Rearing	Spawning gravel, water quality and quantity, cover/shelter, food, riparian vegetation, space, and water temperature	Juvenile and adult
Migration	Substrate, water quality and quantity, water temperature, water velocity, cover/shelter, food[a], riparian vegetation, space, safe passage	Juvenile and adult

[a] Food applies to juvenile migration only.

The life cycle of Snake River fall Chinook salmon gives rise to complex habitat needs, particularly in freshwater. The gravel used for spawning must be a certain size and largely free of fine sediments to allow successful incubation of the eggs and later emergence or escape from the gravel as alevins. Eggs also require cool, clean, and well oxygenated waters for proper development. Juveniles need abundant food sources, including insects, crustaceans, and other small fish. They need instream places to hide from predators (mostly birds and larger fish), such as under logs, root wads, and boulders, as well as beneath overhanging vegetation. They also need refuge from periodic high flows in side channels and off-channel areas and from warm summer water temperatures in cold-water springs and deep pools. Tiffan and Connor (2012) showed that subyearling fish favor water less than 6 feet deep. Returning adults generally do not feed in freshwater, but instead, rely on limited stored energy to migrate, mature, and spawn. Like juveniles, the returning adults also require cool water that is free of contaminants and migratory corridors with adequate passage conditions (timing, water quality/quantity) to allow access to the various habitats required to complete their life cycle (NMFS 2005).

In the following sections, we discuss the current status of the functioning PBFs of critical habitat in the Interior Columbia and Lower Columbia River Estuary recovery domains.

2.2.2.1 Interior Columbia Recovery Domain

The construction and operation of water storage and hydropower projects in the Columbia River basin, including the federal run-of-river dams on the mainstem lower Snake and lower Columbia Rivers, have altered biological and physical attributes of the mainstem migration corridor and continue to affect the value of the PBFs in this habitat via the following: altered habitat and river flows, water use activities (reduced May and June flows), the presence of native and nonnative predators, impaired water quality (e.g., elevated TDG levels), and elevated late summer and fall temperatures. These alterations have affected juvenile migrants to a much larger extent than adult migrants. However, changing temperature patterns have created passage challenges for summer migrating adults in recent years, requiring new structural and operational solutions (i.e., cold water pumps and exit "showers" for ladders at Lower Granite and Lower Monumental dams).

The spawning habitat in the lower Clearwater River can also be negatively affected by high TDG levels from spill events at Dworshak Dam during the winter and spring. Actions taken since 1995 that have reduced negative effects of the federal hydrosystem on juvenile and adult migrants include predator management and many structural and operational changes such as: improved juvenile bypass systems, constructing “surface passage” structures and providing spill to improve passage for smolts; maintaining and improving adult fishway facilities to improve migration passage for adult salmon; flow management, release of water from storage to increase summer flows, release of cool water from Dworshak Dam to reduce peak summer temperatures in the lower Snake River, and minimizing winter drafts (for flood risk management and power generation) to increase flows during peak spring passage.

Chemical contaminants from agricultural, municipal, industrial, and urban land uses have negatively impacted the water quality PBF throughout the migratory corridor as well as in spawning and rearing habitat. Agricultural runoff carries various contaminants from pesticides, fertilizers, and/or animal wastes. The EPA’s *Columbia River Basin State of the River Report for Toxics* (EPA 2009) highlighted the threat of toxic contaminants to salmon recovery in the Columbia River basin. Mercury, dichlorodiphenyltrichloroethane, polybrominated diphenyl ethers, polychlorinated biphenyls, and polycyclic aromatic hydrocarbons are found at levels of concern in many locations along the migration corridor, although some contaminant levels are declining in some areas (EPA 2009).

Spawning and rearing PBFs in the upper Hells Canyon reach, and to a lesser extent in the lower Hells Canyon reach, have been negatively affected by the operation of the HCC. These negative effects include elevated nutrients entering Brownlee Reservoir and associated low dissolved oxygen levels in the late summer and fall exiting Hells Canyon Dam, increased concentrations of pollutants and toxic contaminants, and an altered thermal regime (warmer than historical temperatures) which could negatively affect the survival of adult migrants and the condition of their gametes. However, impacts of the dam on other PBFs in the upper reach have also been mitigated over time by Idaho Power Company's voluntary implementation of: (1) A fall Chinook salmon flow program which provides stable spawning and incubation flows from October to March; and (2) the Juvenile Fall Chinook Salmon Entrapment Management Plan, with operations to reconnect high-priority entrapment sites to the river for at least 2 hours each day.

2.2.2.2 Lower Columbia River Estuary Recovery Domain

Critical habitat has also been designated for Snake River fall Chinook salmon in the lower Columbia River estuary. The estuary is broadly defined to include the entire reach where tidal forces and river flows interact, regardless of the extent of saltwater intrusion. This encompasses areas from Bonneville Dam (RM 146) to the mouth of the Columbia River. It also includes the tidally influenced portions of tributaries below Bonneville Dam, including the lower 26 miles of the Willamette River. This region experiences ocean tides that extend from the mouth of the Columbia River up to Bonneville Dam.

Historically, the downstream half of the Columbia River estuary was a dynamic environment with multiple channels, extensive wetlands, sandbars, and shallow areas. The mouth of the Columbia River was about four miles wide. Winter and spring floods, low flows in late summer, large woody debris floating downstream, and a shallow bar at the mouth of the Columbia River maintained a dynamic environment. Today, navigation channels have been dredged, deepened, and maintained, jetties and pile-dike fields have been constructed to stabilize and concentrate flow in navigation channels, marsh and riparian habitats have been filled and diked, and causeways have been constructed across waterways. These actions have decreased the width of the mouth of the Columbia River to 2 miles and increased the depth of the Columbia River channel at the bar from less than 20 to more than 55 feet (NMFS 2008a).

Over time, more than 50 percent of the original marshes and spruce swamps in the estuary have been converted to industrial, transportation, recreational, agricultural, or urban uses. More than 3,000 acres of intertidal marsh and spruce swamps have been converted to other uses since 1948. Many wetlands along the shore in the upper reaches of the estuary were converted to industrial and agricultural lands after levees and dikes were constructed. Furthermore, water storage and release patterns from reservoirs upstream of the estuary have changed the seasonal pattern and volume of discharge. The peaks of spring/summer floods have been reduced, and the amount of water discharged during winter has increased (NMFS 2008a).

In addition, model studies indicate that, together, hydrosystem operations and reduced river flows caused by climate change have decreased the delivery of suspended particulate matter to the lower river and estuary by about one third (as measured at Vancouver, Washington) and have reduced fine sediment transport by 50 percent or more. The significance of these changes for the value of the PBFs in this habitat is unclear, although estuarine habitat provides food for the large subyearling and yearling migrants from this ESU that move rapidly downstream to the ocean (Johnson et al. 2018).

Functioning estuarine areas are essential to conservation because, without them, juvenile Snake River fall Chinook salmon cannot reach the ocean in a timely manner and use the variety of habitats that allow them to avoid predators, compete successfully, and complete the behavioral and physiological changes needed for life in the ocean. Similarly, these features are essential to the conservation of adult salmonids because these features in the estuary provide a final source of abundant forage that will provide the energy stores needed to make the physiological transition to freshwater, migrate upstream, avoid predators, and develop to maturity upon reaching spawning areas (NMFS 2005).

2.2.3 Climate Change Implications for Snake River Fall Chinook Salmon and Critical Habitat

One factor affecting the rangewide status of Snake River salmon and steelhead and their critical habitat is climate change. For the period 1901–2016, the annual average temperature over the contiguous U.S. increased by about 1.8°F (1.0°C) (Vose et al. 2017). In the Pacific Northwest, annual average temperatures are predicted to increase by 4.67°F (2.59°C) in the mid-Century (2036–2065) relative to average annual temperatures documented for the near-present (1976–2005) (Wuebbles et al. 2017). The U. S. Global Change Research Program projects an increase in average annual temperature of 3.3°F to 9.7°F by 2070 to 2099 (CCSP 2014).

Several studies have revealed that climate change is occurring and accelerating and that it has the potential to affect ecosystems in nearly all tributaries throughout the Snake River (Battin et al. 2007; ISAB 2007). While the intensity of effects will vary by region (ISAB 2007), climate change is generally expected to cause the following:

- Warmer air temperatures, which in turn will result in diminished snowpack and a shift to more winter/spring rain and runoff, rather than snow that is stored until the spring/summer melt season;

- Lower stream flows in the June through September period due to smaller snowpacks;

- Higher flows in winter and possibly higher peak flows as a result of more precipitation falling as rain rather than snow; and

- Warmer water temperatures are expected to rise, especially during the summer months when lower flows co-occur with warmer air temperatures.

The above habitat impacts have negative implications for ESA-listed anadromous fishes in the Pacific Northwest (Climate Impacts Group 2004; Scheuerell and Williams 2005; Zabel et al. 2006; ISAB 2007). Long-term effects include, but are not limited to, depletion of important cold-water habitat, variation in quality and quantity of tributary rearing habitat, alterations to migration patterns, accelerated embryo development, premature emergence of fry, and increased competition among species.

Anadromous salmonids have complex life cycles; they rely on productive freshwater, estuarine, and marine habitats for growth and survival, making them particularly vulnerable to environmental variation. Climate change is predicted to cause a variety of impacts to Pacific salmon (including steelhead) and their ecosystems (Mote et al. 2003; Crozier et al. 2008a; Martins et al. 2012; Wainwright and Weitkamp 2013). Ultimately, the effects of climate change on salmon and steelhead across the Pacific Northwest will be determined by the specific nature, level, and rate of change and the synergy between interconnected terrestrial/freshwater, estuarine, nearshore, and ocean environments.

The primary effects of climate change on Pacific Northwest salmon and steelhead include:

- Direct effects of increased water temperatures on fish physiology;
- Temperature-induced changes to streamflow patterns;
- Alterations to freshwater, estuarine, and marine food webs; and
- Changes in estuarine and ocean productivity.

While all habitats used by Pacific salmon will be affected, the impacts and certainty of the change vary by habitat type. Some effects (e.g., increasing temperature) affect salmon at all life stages in all habitats, while others are habitat-specific, such as streamflow variation in freshwater, sea-level rise in estuaries, and upwelling in the ocean. How climate change will affect each stock or population of salmon also varies widely depending on the level or extent of change, the rate of change, and the unique life-history characteristics of different natural populations (Crozier et al. 2008b). For example, a few weeks' difference in migration timing can have large differences in the thermal regime experienced by migrating fish (Martins et al. 2011).

2.2.3.1 Temperature Effects

Like most fishes, salmon are poikilotherms (i.e., cold-blooded animals); therefore, increasing temperatures in all habitats can have pronounced effects on their physiology, growth, and development rates (see review by Whitney et al. 2016). Increases in water temperatures beyond their thermal optima will likely be detrimental through a variety of processes, including increased metabolic rates (and therefore food demand), decreased disease resistance, increased physiological stress, and reduced reproductive success. All of these processes are likely to reduce survival (Beechie et al. 2013; Wainwright and Weitkamp 2013; Whitney et al. 2016).

By contrast, increased temperatures can increase growth and development rates. Examples of this include accelerated emergence timing during egg incubation stages, or increased growth rates during fry stages (Crozier et al. 2008a; Martins et al. 2011). Temperature is also an important behavioral cue for migration (Sykes et al. 2009), and elevated temperatures may result in earlier-than-normal migration timing. While there are situations or stocks where this acceleration in processes or behaviors is beneficial, there are also others where it is detrimental (Martins et al. 2012; Whitney et al. 2016).

As climate change progresses and stream temperatures warm, thermal refugia will be essential to persistence of many salmonid populations. Thermal refugia are important for providing salmon and steelhead with patches of suitable habitat while allowing them to undertake migrations through or to make foraging forays into areas with greater than optimal temperatures. To avoid waters above summer maximum temperatures, juvenile rearing may be increasingly found only in the confluence of colder tributaries or other areas of cold water refugia (Mantua et al. 2009).

2.2.3.2 Freshwater Effects

Climate change is predicted to increase the intensity of storms, reduce winter snow pack at low and middle elevations, and increase snowpack at high elevations in northern areas. Middle and lower-elevation streams will have larger fall/winter flood events and lower late-summer flows, while higher elevations may have higher minimum flows.

How these changes will affect freshwater ecosystems largely depends on their specific characteristics and location, which vary at fine spatial scales (Crozier et al. 2008b; Martins et al. 2012). For example, within a relatively small geographic area (the Salmon River basin in Idaho), survival of some Chinook salmon populations was shown to be determined largely by temperature, while in others it was determined by flow (Crozier and Zabel 2006). Certain salmon populations inhabiting regions that are already near or exceeding thermal maxima will be most affected by further increases in temperature and, perhaps, the rate of the increases. The effects of altered flow are less clear and likely to be basin-specific (Crozier et al. 2008b; Beechie et al. 2013). However, flow is already becoming more variable in many rivers, and this increased variability is believed to negatively affect anadromous fish survival more than other environmental parameters (Ward et al. 2015). It is likely this increasingly variable flow is detrimental to multiple salmon populations, and likely multiple other freshwater fish species in the Columbia River basin as well.

Stream ecosystems will likely change in response to climate change in ways that are difficult to predict (Lynch et al. 2016). Changes in stream temperature and flow regimes will likely lead to shifts in the distributions of native species and provide "invasion opportunities" for exotic species. This will result in novel species interactions, including predator-prey dynamics, where juvenile native species may be either predators or prey (Lynch et al. 2016; Rehage and Blanchard 2016). How juvenile native species will fare as part of "hybrid food webs," which are constructed from natives, native invaders, and exotic species, is difficult to predict (Naiman et al. 2012).

2.2.3.3 Estuarine Effects

In estuarine environments, the two big concerns associated with climate change are rates of sea level rise and water temperature warming (Wainwright and Weitkamp 2013; Limburg et al. 2016). Estuaries will be affected directly by sea-level rise: as sea level rises, terrestrial habitats will be flooded and tidal wetlands will be submerged (Kirwan et al. 2010; Wainwright and Weitkamp 2013; Limburg et al. 2016). The net effect on wetland habitats depends on whether rates of sea-level rise are sufficiently slow that the rates of marsh plant growth and sedimentation can compensate (Kirwan et al. 2010).

Due to subsidence, sea-level rise will affect some areas more than others, with the largest effects expected for the lowlands, like southern Vancouver Island and central Washington coastal areas (Verdonck 2006; Lemmen et al. 2016). The widespread presence of dikes in Pacific Northwest estuaries will restrict upward estuary expansion as sea levels rise, likely resulting in a near-term loss of wetland habitats (Wainwright and Weitkamp 2013). Sea-level rise will also result in greater intrusion of marine water into estuaries, resulting in an overall increase in salinity, which will also contribute to changes in estuarine floral and faunal communities (Kennedy 1990). While not all anadromous fish species are highly reliant on estuaries for rearing, extended estuarine use may be important in some populations (Jones et al. 2014), especially if stream habitats are degraded and become less productive.

2.2.3.4 Marine Effects

In marine waters, increasing temperatures are associated with observed and predicted poleward range expansions of fish and invertebrates in both the Atlantic and Pacific Oceans (Lucey and Nye 2010; Asch 2015; Cheung et al. 2015). Rapid poleward species shifts in distribution in response to anomalously warm ocean temperatures have been well documented in recent years, confirming this expectation at short time scales. Range extensions were documented in many species from southern California to Alaska during unusually warm water associated with "the blob" in 2014 and 2015 (Bond et al. 2015; Di Lorenzo and Mantua 2016) and past strong El Niño events (Pearcy 2002; Fisher et al. 2015). For example, recruitment of the introduced European green crab increased in Washington and Oregon waters during winters with warm surface waters, including 2014 (Yamada et al. 2015). Similarly, the Humboldt squid dramatically expanded its range northward during warm years of 2004–09 (Litz et al. 2011). The frequency of extreme conditions, such as those associated with El Niño events and/or "blobs" is predicted to increase in the future (Di Lorenzo and Mantua 2016), further altering food webs and ecosystems.

Expected changes to marine ecosystems due to increased temperature, altered productivity, or acidification will have large ecological implications through mismatches of co-evolved species and unpredictable trophic effects (Cheung et al. 2015; Rehage and Blanchard 2016). These effects will certainly occur, but predicting the composition or outcomes of future trophic interactions is not possible with current models.

Wind-driven upwelling is responsible for the extremely high productivity in the California Current ecosystem (Bograd et al. 2009; Peterson et al. 2014). Minor changes to the timing, intensity, or duration of upwelling, or the depth of water-column stratification, can have dramatic effects on the productivity of the ecosystem (Black et al. 2015; Peterson et al. 2014). Current projections for changes to upwelling are mixed: some climate models show upwelling unchanged, but others predict that upwelling will be delayed in spring, and more intense during summer (Rykaczewski et al. 2015). Should the timing and intensity of upwelling change in the future, it may result in a mismatch between the onset of spring ecosystem productivity and the timing of salmon entering the ocean, and a shift toward food webs with a strong sub-tropical component (Bakun et al. 2015).

Columbia River anadromous fishes also use coastal areas of British Columbia and Alaska and midocean marine habitats in the Gulf of Alaska, although their fine-scale distribution and marine ecology during this period are poorly understood (Morris et al. 2007; Pearcy and McKinnell 2007). Increases in temperature in Alaskan marine waters have generally been associated with increases in productivity and salmon survival (Mantua et al. 1997; Martins et al. 2012), thought to result from temperatures that are normally below thermal optima (Gargett 1997). Warm ocean temperatures in the Gulf of Alaska are also associated with intensified downwelling and increased coastal stratification, which may result in increased food availability to juvenile salmon along the coast (Hollowed et al. 2009; Martins et al. 2012). Predicted increases in freshwater discharge in British Columbia and Alaska may influence coastal current patterns (Foreman et al. 2014), but the effects on coastal ecosystems are poorly understood.

In addition to becoming warmer, the world's oceans are becoming more acidic as increased atmospheric carbon dioxide is absorbed by water. The North Pacific is already acidic compared to other oceans, making it particularly susceptible to further increases in acidification (Lemmen et al. 2016). Laboratory and field studies of ocean acidification show that it has the greatest effects on invertebrates with calcium-carbonate shells, and has relatively little direct influence on finfish; see reviews by Haigh et al. (2015) and Mathis et al. (2015). Consequently, the largest impact of ocean acidification on salmon will likely be the influence on marine food webs, especially the effects on lower trophic levels (Haigh et al. 2015; Mathis et al. 2015). Marine invertebrates fill a critical gap between freshwater prey and larval and juvenile marine fishes, supporting juvenile salmon growth during the important early-ocean residence period (Daly et al. 2009, 2014).

2.2.3.5 Uncertainty in Climate Predictions

There is considerable uncertainty in the predicted effects of climate change on the globe as a whole, and on the Pacific Northwest in particular. Many of the effects of climate change (e.g., increased temperature, altered flow, coastal productivity, etc.) will have direct impacts on the food webs that species rely on in freshwater, estuarine, and marine habitats to grow and survive. Such ecological effects are extremely difficult to predict even in fairly simple systems, and minor differences in life-history characteristics among stocks of salmon may lead to large differences in their response (e.g., Crozier et al. 2008b; Martins et al. 2011, 2012). This means it is likely that there will be "winners and losers," meaning some salmon populations may enjoy different degrees or levels of benefit from climate change while others will suffer varying levels of harm.

Climate change is expected to impact anadromous fishes during all stages of their complex life cycle. In addition to the direct effects of rising temperatures, indirect effects include alterations in flow patterns in freshwater and changes to food webs in freshwater, estuarine, and marine habitats. There is high certainty that predicted physical and chemical changes will occur; however, the ability to predict bio-ecological changes to fish or food webs in response to these physical/chemical changes is extremely limited, leading to considerable uncertainty. In addition to physical and biological effects, there is also the question of indirect effects of climate change and whether human "climate refugees" will move into the range of salmon and steelhead, increasing stresses on their respective habitats (Dalton et al. 2013; Poesch et al. 2016).

2.2.3.6 Summary

Climate change is expected to impact Pacific Northwest anadromous fishes during all stages of their complex life cycle. In addition to the direct effects of rising temperatures, indirect effects include alterations in stream-flow patterns in freshwater and changes to food webs in freshwater, estuarine, and marine habitats. There is high certainty that predicted physical and chemical changes will occur; however, the ability to predict bio-ecological changes to fish or food webs in response to these physical/chemical changes is extremely limited, leading to considerable uncertainty. As we continue to deal with a changing climate, management actions may help alleviate some of the potential adverse effects (e.g., hatcheries serving as a genetic reserve and source of abundance for natural populations, increased riparian vegetation to control water temperatures, etc.).

Climate change is expected to make recovery targets for salmon and steelhead populations more difficult to achieve. Climate change is expected to alter critical habitat by generally increasing temperature and peak flows and decreasing base flows. Although changes will not be spatially homogenous, effects of climate change are expected to decrease the capacity of critical habitat to support successful spawning, rearing, and migration. How climate change will affect each population of salmon varies widely depending on the level or extent of change, the rate of change, and the unique life-history characteristics of the populations (Crozier et al. 2008a). Current research looking at species-specific vulnerability to climate change will help guide future species recovery planning efforts.

Habitat restoration actions can help mitigate the adverse impacts of climate change on salmon in freshwater and estuarine habitats. Examples include restoring connections to historical floodplains and freshwater and estuarine habitats to provide fish refugia and areas to store excess floodwaters, protecting and restoring riparian vegetation to ameliorate stream temperature increases, and purchasing or applying easements to lands that provide important cold water or refuge habitat (Battin et al. 2007; ISAB 2007).

2.3 Action Area

"Action area" means all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action (50 CFR 402.02). The site-specific temperature criterion applies to the segment of the Snake River extending from Hells Canyon Dam (RM 247.6), downstream to the Salmon River (RM 188.2). Although the SSC applies to this discrete segment of the Snake River, implementation of the SSC can impact temperatures below the Salmon River confluence. Using information from U.S. Geological Survey (USGS) gages on the Salmon and Snake Rivers (USGS 2019), we calculated the proportion of flow that the Snake River at Hells Canyon Dam represents in downstream reaches. Outflows from the Hells Canyon Dam account for between 53–83 percent of the flow in the Snake below the Salmon River confluence during the spawning season (1965–2018 period of record). The flow at Hells Canyon Dam remains a large contributor of the flow in the Snake River at Anatone, accounting for an average of 69 percent (ranging from 47–80 percent) of the flow over the same period of record. Because the Salmon River contributes cooler water relative to the Snake River, downstream temperature effects of the SSC are dampened below the Salmon River confluence, and further at the confluence with the Clearwater River.

Considering the above information, we have determined the action area based on the extent to which temperature changes could be meaningfully measured downstream. For the purposes of this Opinion, we have assumed that the farthest downstream extent of the action area is located at the confluence of the Clearwater River at RM 139. Because the action is specific to water temperature, the action area is limited to the mainstem Snake River.

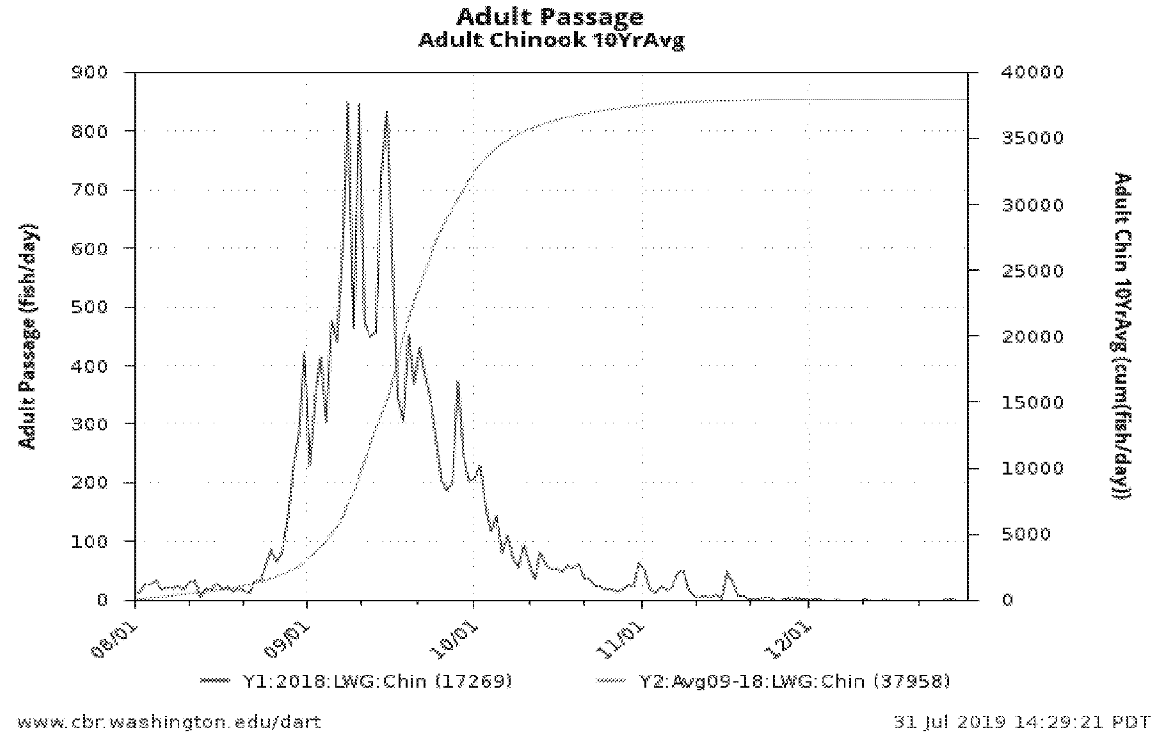
The action area is used by all freshwater life history stages of threatened Snake River fall Chinook salmon. The mainstem Snake River below Hells Canyon Dam and its riparian habitat is designated critical habitat for Snake River fall Chinook salmon. The action area is also EFH for Chinook salmon and coho salmon (PFMC 2014), and is in an area where environmental effects of the proposed action may adversely affect EFH for these species.

2.4 Environmental Baseline

The "environmental baseline" includes the past and present impacts of all federal, state, or private actions and other human activities in the action area, the anticipated impacts of all proposed federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions which are contemporaneous with the consultation in process (50 CFR 402.02). The purpose of this section is to describe the current status of Snake River fall Chinook salmon and its designated critical habitat within the action area. Historic and contemporary anthropogenic activities (e.g., hatchery practices, fisheries, land uses, etc.) along with natural events (e.g. fires, landslides, etc.) have shaped the status of the species and designated critical habitat within the action area. Each of these are discussed in the following sections.

2.4.1 Snake River fall Chinook salmon

Snake River fall Chinook salmon migrate, spawn, and rear in the action area. Both the adult and early life stages (i.e., incubating embryos) of this species will be exposed to the effects of the proposed action. As previously described, the upstream extent of Snake River fall Chinook presence in the action area is the head of Hells Canyon Dam. The majority of Snake River fall Chinook adults pass LGD in September of each year (Figure 4). Connor and Garcia (2006) reported an average of about 45 days for adults to travel from the LGD to spawning sites. Redd surveys have been conducted throughout the action area since the year 1991 (Chandler 2019). Evidence of spawning (redd construction) in the action area has been observed as early as October 9th, but generally does not begin until about October 15th to the 20th (Figure 5). Peak spawning typically occurs about the first week in November (Connor et al. 2011).



Note: fish returning in August can be late-returning Snake River spring/summer Chinook or early-returning fall Chinook.

Figure 4. 2018 daily adult passage and 10-year (2009–2018) average cumulative passage of adult Chinook at LGD.

The number of redds counted in the upper Hells Canyon reach (hereinafter referred to as the "upper reach") and lower Hells Canyon reach (hereinafter referred to as the "lower reach") has increased beginning in the late 1990s (Figure 6). Total annual (aerial) redd counts have fluctuated from as few as 46 total in 1991 (17 in the lower reach and 29 redds in the upper reach) to as many as 3,155 in 2015 (including 828 and 2,327 in the lower and upper reaches, respectively). The highest number of redds counted in the lower reach was 1,419 in 2011 which is the same year that the highest proportion of redds were counted in the lower reach (50 percent) (Figure 6). Even though higher summer temperatures are observed in the upper reach, a slightly higher proportion of redds are typically recorded in this reach above the Salmon River confluence, averaging 57 percent of the total mainstem Snake River (above LGD) redd count over the sampling years 1991–2017 (Figure 6).

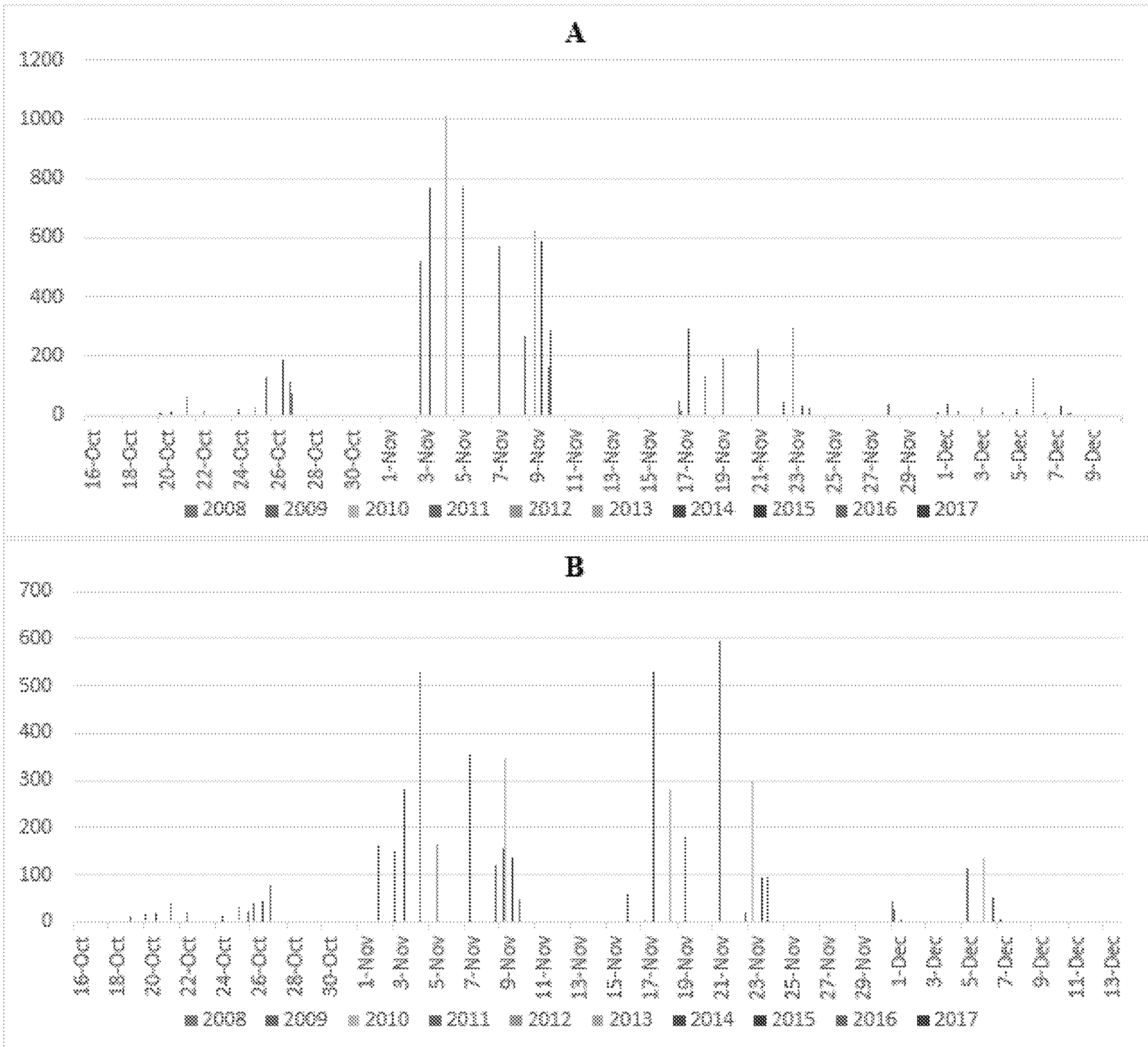


Figure 5. Estimated number of Snake River fall Chinook salmon redds constructed by date in the upper (A) and lower (B) reaches for years 2008–2017 (aerial redd surveys only).

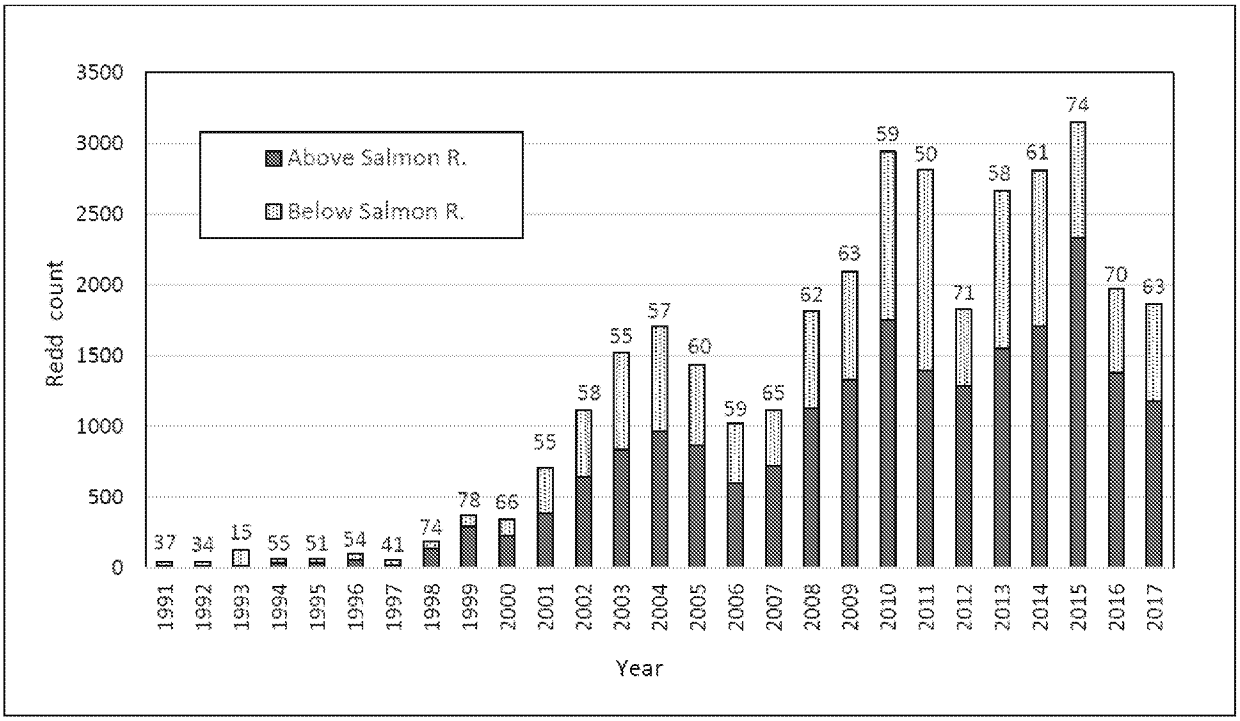


Figure 6. Snake River fall Chinook redd counts (combined aerial and video surveys) for the lower (below Salmon River) and upper (above Salmon River) Hells Canyon reaches of the mainstem Snake River. Bar labels indicate percent of total redds from the upper Hells Canyon reach (EPA 2019).

There are currently two Snake River fall Chinook hatchery fish release sites (and acclimation sites) located within the action area on the mainstem Snake River: Captain John Rapids (annual release of up to 650,000 subyearlings; between the Grande Ronde River confluence and the Clearwater confluence) and Pittsburg Landing (annual release of up to 600,000 subyearlings between Hells Canyon Dam and the Salmon River confluence). All fish released at these locations are reared at the Lyons Ferry Hatchery (NMFS 2018b). In addition to these 1.25 million fish, an additional 1.2 million are released in the Salmon River and the Grande Ronde. Since 2000, the IPC has released approximately 1 million subyearling fall Chinook below Hells Canyon Dam. Recently, the decision was made to move the release of these fish to a site (of equivalent distance to LGD) on the lower Salmon River (NMFS 2018a; 2018b). This release location change is expected to potentially reduce hatchery introgression, and improve the productivity (and potentially the diversity) of naturally produced fall Chinook in the upper Hells Canyon reach of the Snake River. The change is a first step in investigating uncertainties associated with establishing a NPEA for Snake fall Chinook, which has been identified as the most likely recovery scenario for the ESU. In summary, a total of up to 2.45 million fall Chinook salmon are released in the Snake River drainage upstream of the Clearwater River confluence.

Recreational fishing effort in the action area is thought to be minimal to-date and not closely monitored. Any legal harvest of Snake River fall Chinook permitted by the states has only occurred in recent years and has been for ad-clipped Chinook (hatchery) only. The timing has also overlapped with the mainstem steelhead and coho fisheries, and many of the Chinook that have been kept were caught incidentally by anglers targeting steelhead. NMFS recently approved a proposed Fishery Management & Evaluation Plan from the three states for a recreational fall

Chinook fishery upstream of Lower Granite Dam (NMFS 2019a). Under this proposal, natural origin adult fall Chinook salmon may be harvested by tribal and non-tribal fisherman, and harvest rates are based on the abundance of adults at Lower Granite Dam. The total allowable harvest rate ranges from 6–20 percent depending on the run size of natural-origin adults. Managers intend to conduct the fishery in a way which ensures that the distribution of impacts will be proportional to the number and distribution of natural spawner redd count data, so that one segment of the population is not harvested in greater proportion than another segment of the population.

The effects of recent developments and changes to Snake River fall Chinook harvest and hatchery management strategies have yet to be determined. The Snake River hatchery management programs are meant to continue having an overall positive effect in terms of boosting recovery efforts and providing mitigation for losses due to fishery harvest and hydrosystem impacts. The change in release location for one million hatchery fish from the mainstem Snake River (at Hells Canyon Dam) to the Salmon River is expected to improve the productivity (and potentially the diversity) of naturally produced fall Chinook in the upper reach. The recently approved joint state fall Chinook recreational fishery on the mainstem Snake and tributaries is expected to have a small effect on the population.

2.4.2 Snake River Fall Chinook Salmon Designated Critical Habitat

The action area encompasses about 109 miles of the Snake River and is located within the Hells Canyon (hydrologic unit code [HUC] 17060103) and Lower Snake-Asotin subbasins (HUC 17060101). The lower 38 miles of the area form the border between Washington and Idaho, and the upper 71 miles from the border between Idaho and Oregon. Major tributaries of this portion of the Snake River reach include the Clearwater, Imnaha, Salmon, and the Grande Ronde Rivers, as well as Asotin Creek. Together, these tributaries drain a combined area of approximately 19,280 square miles, and have a profound influence on water quality and hydrologic conditions of the Snake River (Nez Perce Tribe and Ecovista 2004).

The upper part of the drainage is forested, mountainous terrain with a deep canyon cut by the Snake River, while the lower part consists of grassland plateaus. Landownership is a mix of Federal (47 percent), private (40 percent), state (12 percent), and NPT (1 percent). Private land is concentrated in the agricultural and urban areas of the lower Snake-Asotin subbasin and of the northern most portion of the Hells Canyon subbasin, near Wolf and Dry Creeks. The vast majority of United States Forest Service (USFS) land is designated as the Hells Canyon National Recreation Area, and a substantial portion of this is further designated as the Hells Canyon National Wilderness Area. In addition, approximately 68 miles of the Snake River, below Hells Canyon Dam, is protected under the Wild and Scenic Rivers Act. These designations afford additional protections in order to preserve the natural character of the area. The Craig Mountain Cooperative Management Area encompasses a large swath of the southeastern portion of the Lower Snake-Asotin subbasin. This area is managed by the NPT, Bureau of Land Management, Idaho Department of Lands, the Nature Conservancy, and private landowners in a manner that provides for the protection and enhancement of wildlife habitat (NPT and Ecovista 2004).

Both historic and present-day land uses have altered the quality of PBFs in the action area. Those land uses include agriculture, grazing, timber harvest, transportation, urban development, and mining. In addition, construction of the HCC of dams from 1959 to 1967 substantially altered the hydrology, water quality, and habitat of the Snake River. Cultivated land in the Lower Snake Asotin subbasin is comprised primarily of dryland crops including wheat; barley; and a legume, oilseed or fallow crop. In the Hells Canyon subbasin, agricultural activity is largely focused on hay production. Livestock grazing is one of the main land uses at Craig Mountain and throughout privately owned lands in the subbasin (NPT and Ecovista 2004). Timber harvest on USFS lands has been relatively limited due to the vast amount of area with Wilderness and National Recreation Area designations. Conversely, timber has been harvested on many of the state and private forest lands in the basin. Gold was discovered on river bars of the Snake River in the 1860s and some placer mining ensued. Placer mining was relatively unsuccessful, although remnants of the activities still remain. Hard rock mining for gold, silver, copper, iron, and lead, occurred through the basin. Currently, only sand, gravel, and stone are mined in the lower portion of the basin.

The vast majority of the area is undeveloped, with few, scattered rural communities. Between 2010 and 2018, population growth was in Nez Perce County was approximately 3 percent, with the vast majority of growth occurring in Lewiston and nearby communities. The Clearwater Paper Lewiston Mill is the only industrial point source discharger in the action area. It discharges treated effluent to the Snake River at RM 140 (near the confluence with the Clearwater River). In addition, EPA has proposed issuance of a discharge permit for multiple parties within the Lewiston urbanized area that are responsible for the discharge of stormwater to the Snake River. There are also point source discharges regulated by the state of Washington in Clarkson and other urbanized areas (e.g., Asotin) that discharge to the Snake River or its tributaries. Together, these point source discharges coupled with nonpoint source discharges (e.g., runoff from roads and agriculture) have impacted water quality in the mainstem Snake River.

2.4.2.1 Hydropower – Hells Canyon Complex

The completion of HCC in 1967 is arguably the most significant anthropogenic activity that has impacted aquatic habitat in the action area. The Hells Canyon Dam does not have fish passage facilities and became the upstream terminus for salmon migration. Water storage and releases associated with operations of the HCC have altered the naturally high peak flows that occurred in the spring as well as altered the daily and hourly flow fluctuations that would otherwise occur naturally. To minimize the impacts of fluctuating flows on spawning fall Chinook salmon, the Idaho Power Company operates the complex of dams to provide stable flows downstream of Hells Canyon Dam.

In addition to altered flows, the complex of dams, especially Brownlee Dam, have altered the natural temperature regime in the Snake River. Water temperatures are typically cooler from October through January and are warmer from May through September (NMFS 2017a). The largest reservoir in the HCC is Brownlee, at the head of the complex, followed by the Oxbow and Hells Canyon Reservoirs. The Oxbow and Hells Canyon Reservoirs have little storage capacity, so most of the water released from Brownlee travels downstream through the Oxbow and Hells Canyon projects within a day. The general effect is that the large thermal mass created by the water stored in these reservoirs delays the peak summer water temperature to a later date and maintains temperatures at a higher level later into the fall relative to what would occur in a natural river condition. While the delay in peak temperature is a consistent trend on an annual basis, a more subtle effect of reservoir operations on water temperatures exists between years. During wet years, the HCC of reservoirs is drawn down for flood control. Refill of these reservoirs occurs in the spring when water temperatures have started to warm. Thus, when this water is released in the summer, it creates a warmer river environment below the projects. Conversely, in a dry year the projects are not drawn so deeply during the winter months for flood control, resulting in less refill, and the water in storage is cooler, thus creating a cooler water environment below the projects during the summer when this water is released. Operation of the reservoirs during the late summer and fall can also have a significant effect on the temperatures that adult spawners experience. Inflows from larger tributaries such as the Salmon River help ameliorate some of these potential effects. A more detailed synopsis of existing temperature conditions is provided in Section 2.4.4.

NMFS (2017a) has recognized that these altered thermal regimes can potentially impact migration, gamete viability, physiological development and may result in mortality. However, the current operations of the HCC also make the thermal environment in this mainstem Snake River reach more conducive to fall Chinook salmon incubation and rearing than it was historically, when it sometimes froze during winter months, leading to reduced egg and fry survival. The current thermal regime, strongly influenced by Brownlee Reservoir, creates warmer conditions during the egg incubation period. These conditions foster earlier fry emergence and influence the timing of other life-history stages (parr and smolt). The altered thermal regime also favors the historically dominant Snake River fall Chinook salmon subyearling life-history strategy. Compared to historical conditions, the earlier emerging fry feed and grow in shoreline rearing areas and then outmigrate earlier, when water-temperature mediated effects such as increased mortality, disease, susceptibility to predation, and reduced physiological development are less severe.

Segments of the mainstem Snake River are impaired for one or more of the following: temperature, mercury, dioxin, total dissolved gas, and low dissolved oxygen (IDEQ 2018; ODEQ 2014; WDOE 2016). The primary habitat limiting factors in the Snake River below Hells Canyon Dam, extending to Lewiston include elevated water temperature, reduced dissolved oxygen, elevated total dissolved gas, altered flows, interruption of geomorphic processes (e.g. sediment transport), and alteration of nearshore rearing habitat (NMFS 2017a). In 2004, the EPA approved the revised version of the Snake River – Hells Canyon total maximum daily load (TMDL) (IDEQ and ODEQ 2004). This TMDL addressed temperature impairments within the Snake River from Hells Canyon Dam to the Salmon River confluence. A temperature load allocation in the form of a required temperature change at Hells Canyon Dam was identified and allocated to the Idaho Power Company for operation of the HCC. That load allocation was defined such that the temperature of water released from the dam is less than or equal to the water temperature at the Brownlee Reservoir inflow (RM 345), or the 7DADM target of 13°C plus no greater than 0.14°C. In 2010, EPA approved the revised Lower Salmon River and Hells Canyon Tributaries Assessments and TMDLs (IDEQ 2010), which addressed thermal and sediment impairments in two tributaries (i.e., Wolf and Divide Creeks) of the Snake River. The TMDL temperature load allocation identified by IDEQ and Oregon Department of Environmental Quality (ODEQ) (2004) has not been achieved to date. Information about whether the thermal and sediment impairments in Wolf and Divide Creeks have been adequately addressed is not available.

The three hydropower projects in the HCC are expected to continue to their operations well into the future, especially given that the three projects combined produce up to 40 percent of the Idaho Power's total annual power generation, which is distributed through southern Idaho and eastern Oregon, where the human population (and their power demands) will continue to grow. The IPC is currently engaged with the Federal Energy Regulatory Commission (FERC) and other stakeholders in the relicensing process for the HCC. The FERC issued a license to IPC for operation of the HCC in 1955. That original license expired in 2005, and the complex currently operates under an annual license. In June 2018, the IPC submitted an application for a 401 certification to both the ODEQ and IDEQ. In their application, the IPC committed to developing and implementing a *"comprehensive and adaptive"* Temperature Management and Compliance Plan (TCMP) (IPC 2018) with the intent of meeting the 2004 TMDL temperature load allocation and complying with downstream water quality criteria. The TMCP includes the IPC's proposed "Snake River Stewardship Program" (SRSP) which is a multi-million dollar restoration program geared toward implementing restoration actions that increase shade and water velocity, decrease water temperatures, and improve water quality. To date, IPC has implemented a few components of the SRSP, including: (1) Floodplain creation; (2) streambank restoration; and (3) conversion of flood irrigation to pressurized irrigation in select locations upstream of the action area (IPC 2019). Although these actions are located outside of the action area, these are among the first suite of actions intended to be implemented in order to collectively help improve water quality conditions in the action area. In May of 2019, both the IDEQ and ODEQ issued final 401 water quality certifications in connection with the federal relicensing of the complex. These certifications contained conditions requiring the IPC to implement their TMCP, including the SRSP. Changes to current system operations that result from the issuance of a new FERC license including conditions required by the 401 water quality certification – will be subject to a separate, future ESA consultation, and so are not considered part of the environmental baseline in this consultation.

2.4.3 Water Temperature

High water temperature in the action area is identified as a limiting factor for Snake River fall Chinook salmon (NMFS 2017a). For purposes of this Opinion, we have characterized the environmental baseline for water temperature from a regulatory (Section 2.4.4.1) and existing condition (Section 2.4.4.2) perspective.

2.4.3.1 Temperature Criteria

In the action area, the Snake River forms a portion of the Idaho, Oregon, and Washington state boundaries. As such, various temperature criteria apply to the Snake River (Table 5). Currently, the Snake River does not meet water temperature criteria in the action area (IDEQ 2018; ODEQ 2014; WDOE 2016). As previously described, the Snake River – Hells Canyon TMDL (IDEQ and ODEQ 2004) assigned a temperature load allocation to the outfall of the Hells Canyon Dam. Compliance with this load allocation within 30 years after the date that FERC issues a new license for the HCC is required by the 401 water quality certifications. As stated above, conditions required by the 401 water quality certification will be incorporated into the FERC license, which will be subject to a separate, future ESA consultation.

In addition, all three states have provisions in their WQS that allow for a 0.3°C increase in stream temperatures due to anthropogenic activities. This increase is intended to be applied as a cumulative increase above the numeric criteria and/or natural condition of the waterbody. NMFS consulted on EPA's approval of Oregon's human use allowance WQS in 2015 (NMFS 2015a). On April 15, 2019, the IDEQ submitted its 0.3°C human use allowance WQS to the EPA for approval. Once approved, this standard would effectively allow for stream temperatures, in the upper Hells Canyon reach to be 0.3°C greater than the applicable temperature criteria.

Table 5. Summary of applicable water temperature criteria for protection of salmonid beneficial uses in the action area.

Snake River Segment	Idaho	Oregon	Washington
Hells Canyon Dam (RM 247) to Salmon River[1] (RM 188)	22°C DMT 19°C MDAT 13°C MWMT (October 23 – April 15)	20°C MWMT 13°C 7DADM (October 23 – April 15)	N/A
Salmon River (RM 188) to Oregon/Idaho/Washington Border (RM 169)[2]	22°C DMT; 19°C MDAT	20°C MWMT 13°C 7DADM (October 23 – April 15)	N/A
Oregon/Idaho/Washington border (RM 169) to downstream extent of action area (RM 139)[2]	22°C DMT 19°C MDAT	N/A	17.5°C MWMT

Abbreviations: DMT = Daily Maximum Temperature; MDAT = Maximum Daily Average Temperature; MWMT = Maximum Weekly (7-day average) Maximum Temperature; 7DADM = Seven-Day-Average of the Daily Maximum Temperature.
[1]Equivalent to the "upper reach" in this Opinion.
[2]Includes a portion of the "lower reach" (RM 188 to 139) in this Opinion.

2.4.3.2 Existing Temperature Conditions

The IPC has collected temperature data within the action area since as early as 1991. The following graphs (Figures 7 and 8) from the IPC (2018) illustrate the current annual temperature regime at the upstream and downstream end of the HCC using data monitored at the inflow to Brownlee Reservoir and outflow from Hells Canyon. Water depth and summer stratification in the Brownlee Reservoir results in contributions of colder water to the downstream reach through the summer. However, water temperatures at the Hells Canyon Dam outflow exceed Idaho's cold water aquatic life temperature criterion throughout the summer months and into the fall.

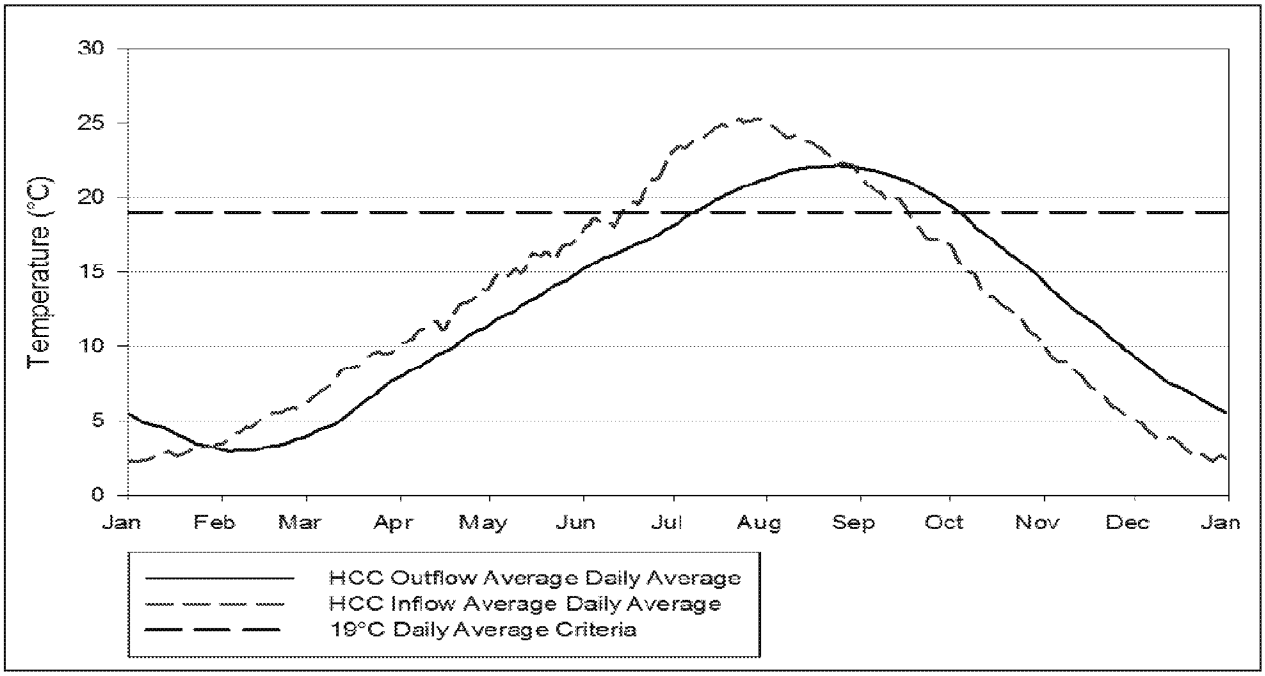


Figure 7. Average daily temperatures for the inflow from Brownlee Reservoir (1996–2017) and the outflow at Hells Canyon Dam (1991–2017) (Source: IPC 2018, Figure 6.5-1).

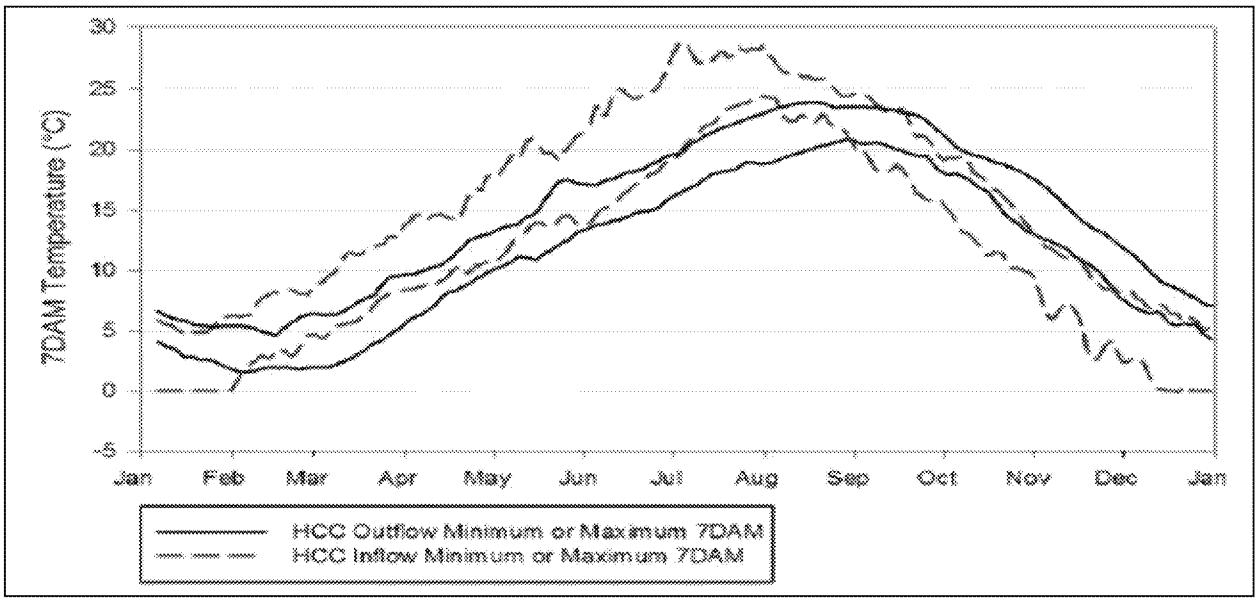


Figure 8. Minimum and maximum 7DADM temperature for Brownlee Reservoir inflow (1996–2017) and Hells Canyon Dam outflow (1991–2017) (Source: IPC 2018, Figure 6.1-7)

Using the IPC and USGS temperature data, EPA (2019) generated a longitudinal temperature profile of the Snake River extending from the Hells Canyon Dam downstream to below the Clearwater River confluence (Figure 9). Observed water temperatures are well above the current fall spawning criterion of 13°C MWMT, as well as above the proposed new standard (14.5°C 7DADM).

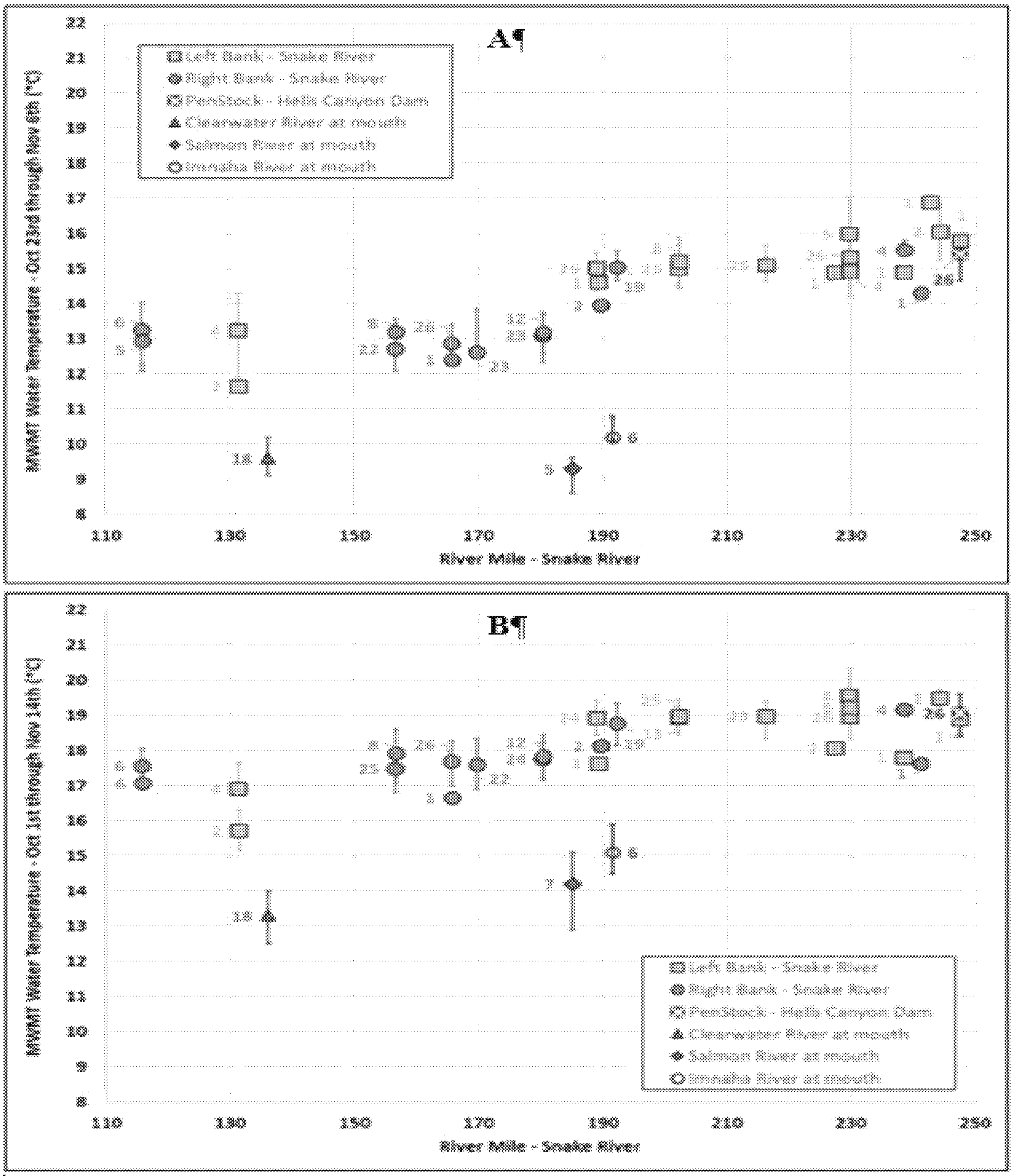


Figure 9. Longitudinal profile of Snake River temperatures. Recorded MWMT for the October 23–November 6 (A) and for the October 1–November 14 (B) time periods between 1992 and 2018. Bars represent the 25th and 75th percentile values, and numbers represent the number of years with data (EPA 2019).

Table 6 displays the range of 7DADM temperatures collected at four different locations in the lower reach and at six different locations in the upper reach. This demonstrates that the 14.5°C standard has continually been exceeded in the upper reach during its period of applicability[2], at least since the year 2000.

Table 6. Range of 7DADM temperatures (°C) calculated using IPC data collected in the lower and upper reaches of the mainstem Snake River. Bolded values are in excess of the SSC.

Year	Lower Reach[1]				Upper Reach[2]			
	Oct 23–Nov 6		Oct 29–Nov 6		Oct 23–Nov 6		Oct 29–Nov 6	
	Lowest	Highest	Lowest	Highest	Lowest	Highest	Lowest	Highest
2000	10.7	14.1	10.7	12.7	13.3	16.1	13.3	**15**
2001	12.2	14.6	12.2	13.5	15.5	16.9	14.4	**15.8**
2002	9.1	13.8	9.1	12.5	11.8	15.9	11.8	**15.3**
2003	10.4	15.9	10.4	**14.9**	13.2	17.7	13.2	**16.9**
2004	11.2	15.1	11.2	13.4	13.8	17.4	13.8	**16.3**
2005	12.3	15.1	12.3	14.1	14	16.5	14	**15.8**
2006	9.5	14	10.3	12.8	13	16.3	13	**15.3**
2007	10.2	13.5	10.6	12.2	12.9	15.6	13	**14.7**
2008	11.4	13.4	11.4	12.6	13.5	15.9	13.5	**15**
2009	10.4	13.6	10.4	12.6	12.7	15.5	12.7	**14.6**
2010	12.5	14.8	12.5	13.6	14.9	17.8	**14.9**	**16.8**
2011	11.2	15	11.1	13.6	13.3	16.7	13.3	**15.4**
2012	11.8	14.6	11.8	12.5	14.2	16.8	14.3	**15.8**
2013	10.5	13.2	10.5	12.4	13.1	16	13.1	**15.3**
2014	13.2	15.8	13.2	14.4	15.7	18	**15.7**	**17.2**
2015	13.5	17.1	13.5	**15.8**	15.8	18.6	**15.8**	**18**
2016	11.2	14.1	11.2	13.9	15.6	16.4	14.6	**15.8**
2017	10.1	12.6	10.1	12.1	12.7	15.3	12.7	14.4

[1]Data collected at four locations: RM 156.6, RM 165.7, RM 169.7, and RM 180.3.
[2]Data collected at six locations: RM 189.0, RM 192.3, RM 202.3, RM 216.3, RM 229.8, and RM 247.6.

Cold Water Refuges. There has been some work to evaluate the occurrence of cold water refuges in the Hells Canyon reach. Cold water refuges are patches of cooler water that are important habitat features for adult and juvenile salmon during periods of elevated temperatures. Ebersole et al. (2015) defined cold water refuges as patches of water that are $\geq$3°C colder than the ambient stream temperature. The occurrence of cold water refuges in mainstem rivers such as the Snake River are spatially complex and are influenced by the contribution of cold water from a variety of sources such as confluences with colder tributaries, inputs from small perennial streams, input from groundwater upwelling, and subsurface flows from intermittent and ephemeral channels (Ebersole et al. 2015). As discussed by Fullerton et al. (2015), determining if adequate cold water refuges are available is a complex question because there are many factors to consider including: the size of the cold-water patches, the distribution and frequency of the patches, and

[2] As described in Section 1.3, the first 7DADM that can be compared to the numeric criterion is calculated on October 29, and includes data collected from October 23rd through October 29.

whether they are available at the actual time-periods and actual locations when they are needed by the fish.

The IDEQ and ODEQ 2004 TMDL found that bull trout and steelhead, which can be present in the summer and fall months in this section of the Snake River escape through the multiple colder tributaries available as refuges (IDEQ 2004). A study by Chandler et al. (2003) showed that the rainbow trout populations in the HCC and rainbow trout and bull trout downstream were using cold-water refugia provided by tributaries by either migrating upstream into the tributaries or associating with the cold-water plume of the tributaries during the summer months. Using the State of Oregon definition of cold water refugia (CWR) of ≥2°C colder than the ambient (i.e. mixed) water, Idaho Power (2018, Exhibit 6.1-1)) evaluated temperature data from Hells Canyon corridor streams to identify the likely contributions of cold water. They compared temperature data from two sets of perennial streams (low and high elevation headwaters) and the Imnaha River to Snake River temperature data collected at two locations. The IPC found that all of the tributaries examined provided CWR during at least some portion of the day, with the exception of a few days in the middle of July. Furthermore, the daily average temperatures of tributaries started to drop below the -2°C difference by mid-August, suggesting CWR is available during the majority of the diel cycle.

2.4.3.3 Climate Change

In an assessment of stream temperature data using the NorWest statistical stream network model from more than 20,000 sites in the western U.S., Isaak et al. (2017) found that Pacific Northwest river and stream August mean temperatures have increased by an average of 0.17°C per decade (standard deviation = 0.067°C per decade) from the reconstructed trend over 40 years (1976–2015). For larger rivers, estimated trends from time series at 391 sites across the northwestern U.S. revealed that warming trends are ubiquitous in the summer and fall months (July–September) in the recent 20-year period (1996–2015), with mean river temperature increases of 0.18–0.35°C per decade (Isaak et al. 2018). They found that the average regional increase is largely linked to air temperature increases across the Pacific Northwest; however, at a local to sub-regional scale, other drivers such as changes in discharge, can be influential.

The EPA (2019) noted a pattern of increasing Snake River temperatures over the years at RM 229.8. From September 1 through October 22, daily maximum temperatures during the 2010–2018 time period were, on average, 1°C (ranging from 0.4–1.5°C) warmer than daily maximum temperatures recorded during the 1991–1999 time period (Figure 10).

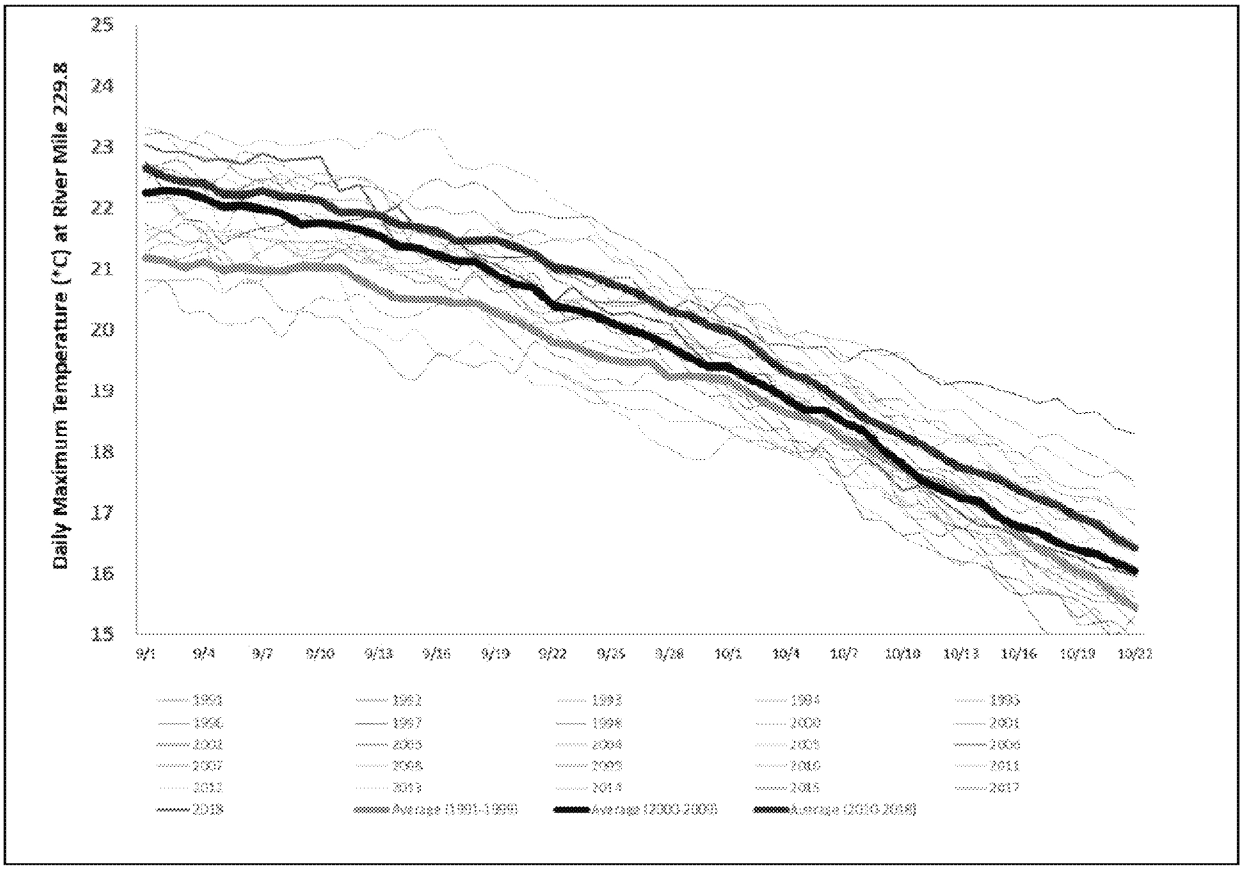


Figure 10. Compilation of daily maximum temperatures for 1991–2019 at RM 229.8 in the mainstem Snake River. Thick lines represent mean temperatures for each decade (EPA 2019).

Likely changes in stream flow and temperature as a result of climate change have implications for survival of Snake River fall Chinook salmon in their freshwater. Altered stream flows and water temperatures are currently considered limiting factors for Snake River fall Chinook salmon in the mainstem Snake River (NMFS 2017a). All other threats and conditions remaining equal, future deterioration of water temperatures due to climate change could reduce viability or survival of fall Chinook salmon. Potential effects associated with increased water temperatures could include passage delays, reduced egg and fry survival, pre-spawn mortality, a shift in fry emergence and outmigration timing, reduced prey availability, and increased predation. The magnitude of these effects will depend on how Snake River fall Chinook salmon respond to the changes (e.g., later adult migration and spawn timing, reduced incubation time to emergence, faster fry/parr growth rates, etc.), which remains unclear. One thing that is certain is that as climate change continues to impact conditions in the mainstem Snake River, cold water refuges will become increasingly important into the future.

2.5 Effects of the Action

Under the ESA, "effects of the action" means the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline (50 CFR

402.02). Indirect effects are those that are caused by the proposed action and are later in time, but still are reasonably certain to occur.

The following effects analysis draws information from available scientific literature, the *EPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards* (hereinafter referred to as the Temperature Guidance) (EPA 2003), the biological opinion for Oregon's temperature criteria (NMFS 2015a), and the BE (EPA 2019). At the time of its issuance, the Temperature Guidance contained the best available scientific information on the thermal requirements of salmon, and was endorsed by NMFS (April 23, 2003 letter from Robert Lohn, NMFS to John Iani, EPA Region 10). Since that time, updated information on fall Chinook temperature has become available and is included in this Opinion.

In evaluating the effects of the action, we considered, among other things, the following questions:

1. Since the criterion is a rolling 7-day average, and considering the declining thermal regime during the fall, how would adoption of the 14.5°C as a MWMT criterion influence water temperatures during and prior to the time-period during which it applies?

2. Would stream temperatures associated with the 14.5°C (as a MWMT between October 23 and November 6), adversely affect gamete viability or embryo survival? If so, to what degree would juvenile abundance at LGD be reduced?

3. How does the current temperature regime and status of the species inform our effects analysis?

As defined under the ESA, the environmental baseline includes the impacts of all past federal actions. The environmental baseline is the temperature criterion that is effective for CWA purposes (i.e., 13°C MWMT); however, temperatures in the mainstem Snake River do not comply with this temperature criterion and have not complied since before the early 2000s. As alluded to in Question 3 above, the existing thermal conditions in the mainstem Snake River provide insight upon which we can judge the likely impacts of the proposed action.

2.5.1 Impact on Stream Temperatures below Hells Canyon Dam

The proposed criterion is a 7DADM metric that reflects an average of the maximum temperatures fish are exposed to over a week-long period. Thus, it reflects maximum temperatures in a stream, but it is not overly influenced by the maximum temperature of a single day.

Under the proposed site-specific criterion, the first 7DADM averaging period is from October 23 through October 29. This effectively means that in order to comply with the SSC, the 7DADM on October 29 must not exceed 14.5°C. Because the SSC is a rolling 7-day average and applies at a time when stream temperatures are declining, we must consider stream temperatures in the days preceeding application of the SSC in order to consider the full scope of proposed action's potential effects. Thus, we also must account for the rate at which stream temperatures are decreasing at this time of year. The EPA determined that during this time of year, there is an average daily reduction of 0.2°C in stream temperatures in the mainstem Snake River at

RM 229.8. Assuming a consistent daily reduction in stream temperatures equivalent to 0.2°C would mean that the daily maximum temperature on October 23 should be no greater than 15.1°C (Table 6). As described in section 2.4.2.1, both Oregon and Idaho WQS contain a 0.3°C human use allowance. The IDEQ and ODEQ determined that the HCC was solely responsible for the Snake River exceeding the salmonid spawning criteria downstream of the Hells Canyon Dam (IDEQ and ODEQ 2004). Thus, the IPC received the entire 0.3°C cumulative increase in stream temperatures above the salmonid spawning criterion. Considering this, it is possible that daily maximum stream temperatures could be as high as 15.4°C on October 23 and still comply with the proposed SSC[3].

Table 7. Comparison of daily maximum temperatures that could occur between October 8 and October 29 and still achieve compliance with a 14.5°C and 13°C 7DADM on October 29 (assuming a 0.2°C daily temperature decline). Also shown is an average of the maximum daily temperatures recorded at Hells Canyon Dam penstock (1991–2018).

Date	Maximum Daily Temperature To Achieve 14.5°C[1] 7DADM on 10/29	Maximum Daily Temperature to Achieve 13.0°C[1] 7DADM on 10/29	Average Maximum Daily Temperature at Hells Canyon Dam[2] (1991–2018)
10/08	18.1	16.6	18.3
10/09	17.9	16.4	18.1
10/10	17.7	16.2	18.0
10/11	17.5	16.0	17.8
10/12	17.3	15.8	17.6
10/13	17.1	15.6	17.5
10/14	16.9	15.4	17.3
10/15	16.7	15.2	17.2
10/16	16.5	15.0	17
10/17	16.3	14.8	16.7
10/18	16.1	14.6	16.6
10/19	15.9	14.4	16.5
10/20	15.7	14.2	16.3
10/21	15.5	14.0	16.2
10/22	15.3	13.8	16.1
10/23	15.1	13.6	15.9
10/24	14.9	13.4	15.7
10/25	14.7	13.2	15.6
10/26	14.5	13.0	15.4
10/27	14.3	12.8	15.3
10/28	14.1	12.6	15.1
10/29	13.9	12.4	14.9

[2]Data obtained from the IPC (Myers 2019).

Idaho's daily average temperature of 19°C for the protection of cold water aquatic life, and Oregon's 20°C 7DADM for protection of salmonid migration serve as backstops to how high temperatures may be and still comply with WQS. Based on temperature data collected by the IPC, the highest 95th percentile difference between the daily maximum and daily average

[3] The IDEQ issued a waiver that allows for the increase of 0.3°C above the applicable 13°C salmonid spawning temperature criterion for the Snake River below Hells Canyon Dam from October 23 to November 6 (May 19, 2019 letter from IDEQ to IPC). Temperatures listed in columns 1 and 2 do not reflect that de minimis allowance.

temperatures recorded in the upper reach was 0.56°C. Applying this to the 19°C daily average criterion, daily maximum temperatures during the time when adult fall Chinook salmon may be present in the action area prior to the October 8, could be as high as 19.6°C (or 19.9°C if applying the human use allowance) and still comply with criteria. Oregon's migratory corridor criterion is meant to be implemented as a summer maxima, which appears to generally occur between mid-August and mid-September (Figure 8). As such, when complying with all criteria, effects may be lessened from what was previously described as a result of the gradual decline of up to 0.2°C per day between application of the migration corridor criteria in summer and the spawning criteria later in the fall.

2.5.2 Effects on Snake River fall Chinook salmon

Water temperature affects adult survival, gamete viability, embryo survival and rate of development, and fry survival (Bjornn and Reiser 1991). Fall Chinook salmon spawn in the late summer when water temperatures are declining and continue to decline through incubation. Because water temperature affects the rate of development, thermal regimes that cool rapidly are essential for ensuring proper emergence timing (EPA 2003).

2.5.2.1 Egg Incubation and Early Life Stages

Although a number of studies have been conducted in the past on temperature effects during early stages of salmonid development, there remains uncertainty regarding the appropriate threshold temperature to prevent significant mortality and/or compromised development in eggs and fry. The vast majority of research was conducted on species other than fall Chinook salmon, and there is reason to believe fall Chinook salmon are more tolerant of higher temperatures than other stocks of Chinook salmon. Seymour (1956) reported low mortality and defect rates for summer/fall Chinook salmon eggs reared in constant temperatures between 4.4–12.8°C. Mortality and defects increased substantially when eggs were incubated in constant temperatures greater than 15.5°C, in fact, one hundred percent mortality in the yolk-sac stage) occurred when eggs were incubated at constant temperatures of 15.5°C and 16.9°C. While these results are insightful, they do not represent field conditions, where temperatures are declining during the spawning and incubation periods.

Seymour (1956) also conducted an experiment using variable temperatures (i.e., temperatures declined during the incubation period). Low mortality rates (i.e., ≤6 percent) were observed where the starting temperatures (expressed as a daily average) ranged between 7.2–15.5°C. Substantial increases in mortality (i.e., 10 times greater) were documented when the starting temperatures were 18.3°C (Seymour 1956). Olson and Foster (1957) also studied mortality of eggs fertilized in the field using fall Chinook salmon adults captured from spawning grounds in the Columbia River relative to variable thermal regimes. The authors observed lower overall mortality rates of fall Chinook salmon when eggs were incubated in initial temperatures as high as 16.1°C (10 percent mortality rate) relative to the control temperature of 13.9°C (16 percent mortality rate). Substantial mortality (i.e. 79 percent) of young fall Chinook salmon when eggs were incubated in initial temperatures of 18.3°C were also reported. In a separate study, Olson et al. (1970) exposed eggs from four separate stocks of Chinook to variable temperature regimes. In that study, temperatures were decreased by 0.2°C each day until they reached 1°C. Temperatures were held constant at this temperature for 20 days before being raised by 0.2°C each day until the end of the experiment. The authors reported the following percent mortalities for each respective thermal initiation regime: 4.5 (12.6°C); 3.6 (13.7°C); 11 (14.8°C); 28.1 (15.9°C); 59.6 (17°C); 97.4 (18.1°C); and 100 (19.2°C). While statistically significant differences in mortality were observed between control and higher test temperatures, the authors noted than the 11 percent overall mortality recorded for eggs incubated at initial temperatures of 14.8°C was similar to average mortalities (i.e., 15 percent) at USFWS fall Chinook rearing stations at Spring Creek and Little White Salmon on the Lower Columbia.

The Independent Scientific Group (ISG) (1996) stated that optimal temperature for anadromous salmonid spawning is 10°C (plus or minus a few degrees above and below), stressful conditions began at temperatures greater than 15.6°C, and lethal temperatures occur at 21°C (for 1-week exposures). The ISG acknowledged that different Chinook salmon stock have evolved or been selected to tolerate quite divergent environmental conditions and habitats. After reviewing a large body of literature, including those summarized above, McCullough et al. (2001) concluded that "spawning initiated as daily maximum temperatures fall below 12–14°C results in greater incubation success, with 12.8°C being adequate for most salmon species." The authors further stated that "a spawning temperature range of 5.6–12.8°C (maximum) appears to be a reasonable recommendation for Pacific salmon, unless colder thermal regimes are natural in any tributary." Richter and Kolmes (2005) reviewed the same information considered during development of the Temperature Guidance and recommended a 13°C criterion for the protection of spawning and rearing. In the 2015 biological opinion for EPA's approval of Oregon's temperature criteria, NMFS concluded that a spawning temperature criterion of 13°C (7DADM) would not result in increased deaths or injury among individual fall Chinook salmon. Because the proposed action considered in that consultation did not include temperatures greater than 13°C for the protection of spawning, NMFS did not examine whether higher thresholds would be sufficiently protective.

Based on the information above, additional mortality of incubating embryos or reduced survival of alevins may occur as a result of egg exposures to temperatures that would be allowed to occur under the proposed SSC (i.e., temperatures ≥14.8°C) relative to the current criterion. As described in Section 2.5.1 (and summarized in Table 7), the proposed SSC would allow for temperatures greater than 14.8°C to occur as late as October 24, compared to the existing criterion, which allows for temperatures greater than 14.8°C to occur as late as October 17. Said another way, the proposed SSC allows for more days to exceed the 14.8°C, relative to the current criterion.

2.5.2.2 Gamete Viability and Adult Pre-Spawn Mortality

Higher water temperatures experienced during the spawning migration could lead to prespawn mortality or diminished reproductive success (Goniea et al. 2006; Mann 2007; Schreck et al. 1994). McCullough et al. (2001) conducted a literature review and reported that detrimental effects on the size, number, and/or fertility of eggs held in vivo occurred when adult fish were exposed to constant or average temperatures greater than 13-15.6°C prior to spawning. Billard and Breton (1977, as cited by EPA 2003) found that holding females at 20°C for 70 hours reduced viability of eggs compared to females held at 10°C. Mortality of eggs to the eyed stage of development reached 30 percent when adults were held prior to spawning in temperatures of 15.6–16.7°C and eggs were incubated at temperatures from 12.7–13.3°C. Egg mortality of 20 percent was observed when adults were held prior to spawning in temperatures up to 15°C. The lowest mortality (i.e., 5 percent) occurred when adults were held at 11.7–12.2°C (Hinze et al. 1956, as cited in EPA 2003). Berman held spring Chinook adults at temperatures ranging from 14–15.5°C (the control group) and 17.5–19°C (experimental group) for a 2-week period. Progeny of the experimental group had higher prehatch mortality and a greater rate of developmental abnormalities. Progeny of the control group had relatively low rates of mortality and developmental abnormalities. Based on an extensive literature search, EPA (2003) recommended a temperature criterion of 13°C, expressed as a 7DADM would be protective of developing gametes. NMFS (2015a) agreed with this assessment; however, NMFS did not examine whether higher thresholds would be sufficiently protective.

More recent work has been performed and warrants some consideration. Jensen et al. (2006) evaluated the effects of water temperature on adult summer Chinook salmon and reported excess egg mortality (11.8–13.4 percent) when adults were held in elevated water temperatures (i.e., 15.5–23.5°C) compared to egg mortality (about 3 percent) when adults were held in cooler water temperatures (i.e. 8–9°C). Mann and Peery (2005) performed a limited study on embryo loss relative to thermal regimes experienced by female adult Chinook salmon. They found that five fish with the highest temperature exposures (2–7 degree days above 20°C) had five of the six highest embryo mortalities (ranged between about 3–9 percent for each developmental stage examined). Interestingly, the fish with the highest embryo mortality (i.e., 19 percent for each developmental stage) had only minor exposure to daily temperatures over 18°C. These studies suggest reduced gamete viability will occur when adults are exposed to elevated temperatures.

2.5.2.3 Fall Chinook Salmon Adaptations

Many salmon stocks have adapted to their locales, which likely enhances survival and reproductive success (Nehlsen et al. 1991, Sheridan 1962, Royce 1962, Burger et al. 1985, Brannon 1987, NMFS 1998). Results from some studies suggest fall Chinook salmon are likely more tolerant of upper temperature ranges compared to their spring/summer chinook cohorts. In the Hanford reach and in the Snake River in Washington, redd construction began as weekly mean temperatures dropped to 15.9°C and averaged 13.6°C during the weeks of spawning initiation from 1993–1995 (Groves and Chandler, 1999). NMFS (Robert Lohn, letter sent to John Iani, Regional Administrator, EPA, April 23, 2003, regardng EPA Region 10 temperature guidance) recognized that "*…in some instances, local fish populations may be supported by criteria different (either warmer or cooler) than the criteria in the guidance…*". The resilience of the Hanford Reach fall Chinook population to warmer average temperatures is of particular significance to this Opinion, as these fish have been found to be most closely related to Snake River fall Chinook (NMFS 2017a).

A relatively recent study specific to Snake River fall Chinook salmon was conducted by Geist et al. (2006). For this study, the authors incubated Snake River fall Chinook salmon embryos in conditions that mimicked the variable thermal and oxygen regimes in the mainstem Snake River below Hells Canyon Dam. Percent mortality from fertilization to emergence for each thermal regime (where dissolved oxygen was at saturation) was reported as 16.6 (13°C); 4.5 (15°C); 4.2 (16°C); 6.2 (16.5°C); and 98.3 (17 °C). This study suggests that mortality of embryos incubating at initial temperatures of 14.5°C would not be expected to be significantly greater than that observed at 13°C. However, these results should be viewed with some caution because hatchery protocols dictated that the pre-spawn adult salmon be held at a constant water temperature of 12°C, which may have protected gametes and improved later survival of incubating embryos. In addition, eyed eggs from the 13°C treatment had to undergo an acclimation step prior to being transferred into the living stream system. Eyed eggs from the other thermal treatments did not undergo this step. It is possible that the relatively rapid acclimation period (i.e. warming water with eyed eggs from about 5°C to 8.5°C at a rate of approximately 0.2°C every 30 minutes) contributed to increased mortality.

Thermal regimes historically experienced by fall Chinook in the Snake River. The core population of Snake River fall Chinook salmon historically occupied the mainstem Snake River primarily upstream of Swan Falls Dam. They were closely associated with the warmer winter thermal regime of the Middle Snake River, which was significantly influenced by the discharge of the Eastern Snake Plain Aquifer (ESPA). The thermal pattern of the Snake River is unique from other rivers because of the high volume of groundwater stored in this aquifer. In total, approximately 5,000 cubic feet per second of groundwater enters the Snake River (between approximately RM 553 and RM 620) in the form of springs that flow from basalt cliffs. The warm water (i.e., average temperature of 15.5°C) inputs from the ESPA translated into warmer incubation temperatures and earlier emergence dates for fall Chinook salmon, supporting a subyearling life-history strategy (NMFS 2017a).

Prior to the construction of the HCC, the upper and lower Hells Canyon reaches of the Snake River were relatively cold, and surviving fry[4] would have emerged late relative to those in historically occupied spawning areas of the Snake River. This colder thermal regime was similar to the Salmon River, which does not currently support substantial fall Chinook spawning and is not believed to have supported significant fall Chinook salmon spawning historically either.

Thermal regimes experienced by an unlisted summer/fall Chinook salmon population. The Hanford Reach fall Chinook population is part of the Upper Columbia River summer/fall Chinook salmon ESU and is one of the most productive Chinook salmon populations on the West Coast of the United States (NMFS 2019b). This ESU is considered closely related to the Snake River fall Chinook salmon ESU. NMFS examined the relationship between the spawning redd counts and WMT for the Vernita Bar reach within this population. Our examination included data collected between 2004 and 2016. As illustrated in Figure 11, some spawning in this reach occurs when temperatures, expressed as a WMT, are at or above 14.5°C. Though many differences such as habitat availability and quality do exist between the Hanford Reach and Snake River fall Chinook populations, the continued high productivity of this natural-producing population suggests existing thermal regimes, which are greater than 14.5°C during the early part of the spawning period, are not impacting production to a degree that is leading to population declines.

[4] Fall Chinook eggs incubated below 3°C can experience substantial egg-to-fry mortalities.

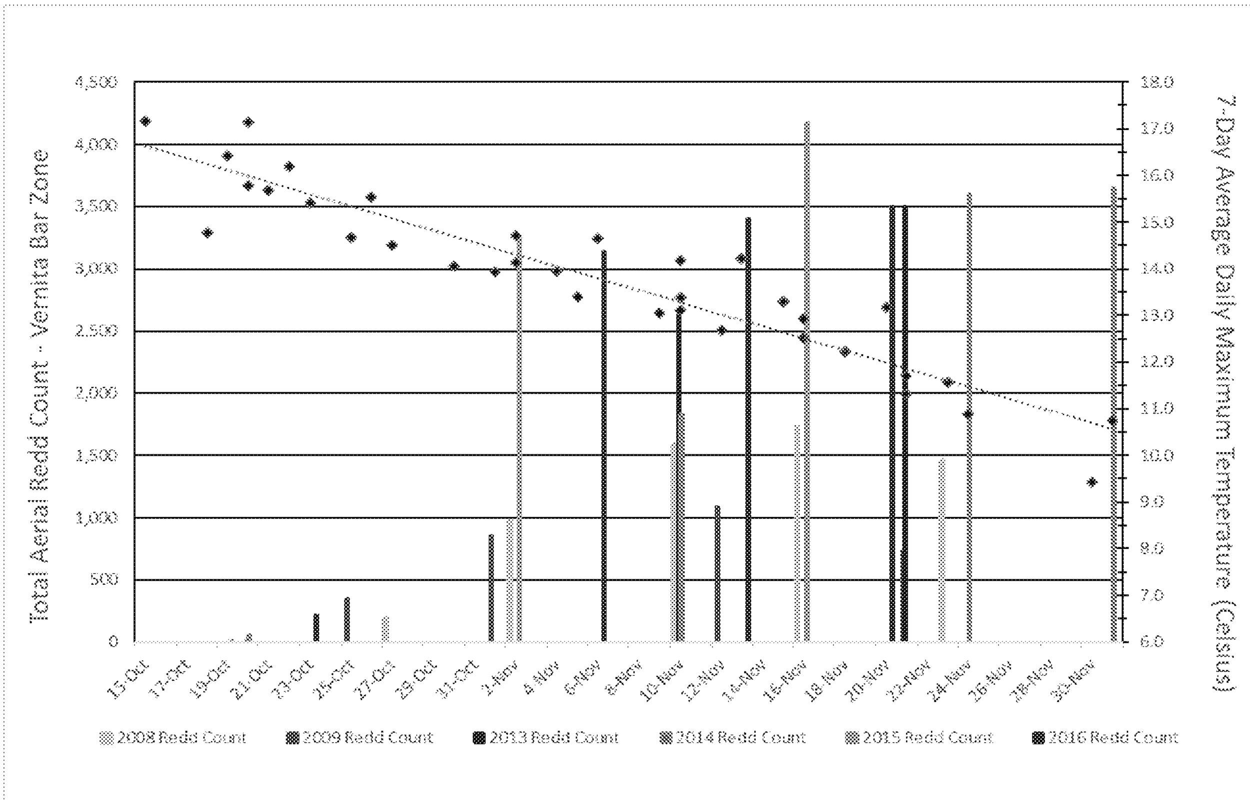


Figure 11. Vernita Bar reach fall Chinook redd counts and 7DADM temperatures (°C) (2008–2016, not including 2010, 2011, 2012 due to lack of comparable data).

Thermal regimes currently experienced by Snake River fall Chinook salmon in the Snake River. As described in the environmental baseline, Snake River fall Chinook salmon are currently exposed to temperatures greater than what would be allowed under the proposed action. When comparing stream temperatures to cumulative percent frequency of redd counts, Connor (2015) estimated that redd loss due to elevated temperatures (i.e., when stream temperatures are greater than 16.5°C) ranged from 0.2–7 percent.

NMFS examined water temperature data (expressed as a daily maximum temperature) and cumulative aerial redd counts (2010–2017) in the upper and lower reach (Figure 12). In most years (i.e., 2010–2013 and 2016–2017), redd counts were initiated after stream temperatures were below 17°C (the temperature where Geist et al. [2006] reported 98 percent mortality), thus it was not possible to calculate a cumulative percent of redds that may have been exposed to such temperatures without extrapolation. Assuming all redds observed on the initial observation data were constructed during the 7 days prior, approximately 1 percent or less of the redds were exposed to 17°C during those years. During 2014 and 2015, a larger proportion of redds in the upper Hells Canyon reach (i.e., 25 and 42 percent, respectively) are estimated to have been constructed when stream temperatures were above 17°C. As expected, a much smaller proportion of redds in the lower reach were impacted, with 4 percent or less impacted in 2014 and 2015. These are likely conservative estimates because we have employed a linear interpolation. It is possible that the rate of redd construction is not linear, but instead may increase as temperatures decline.

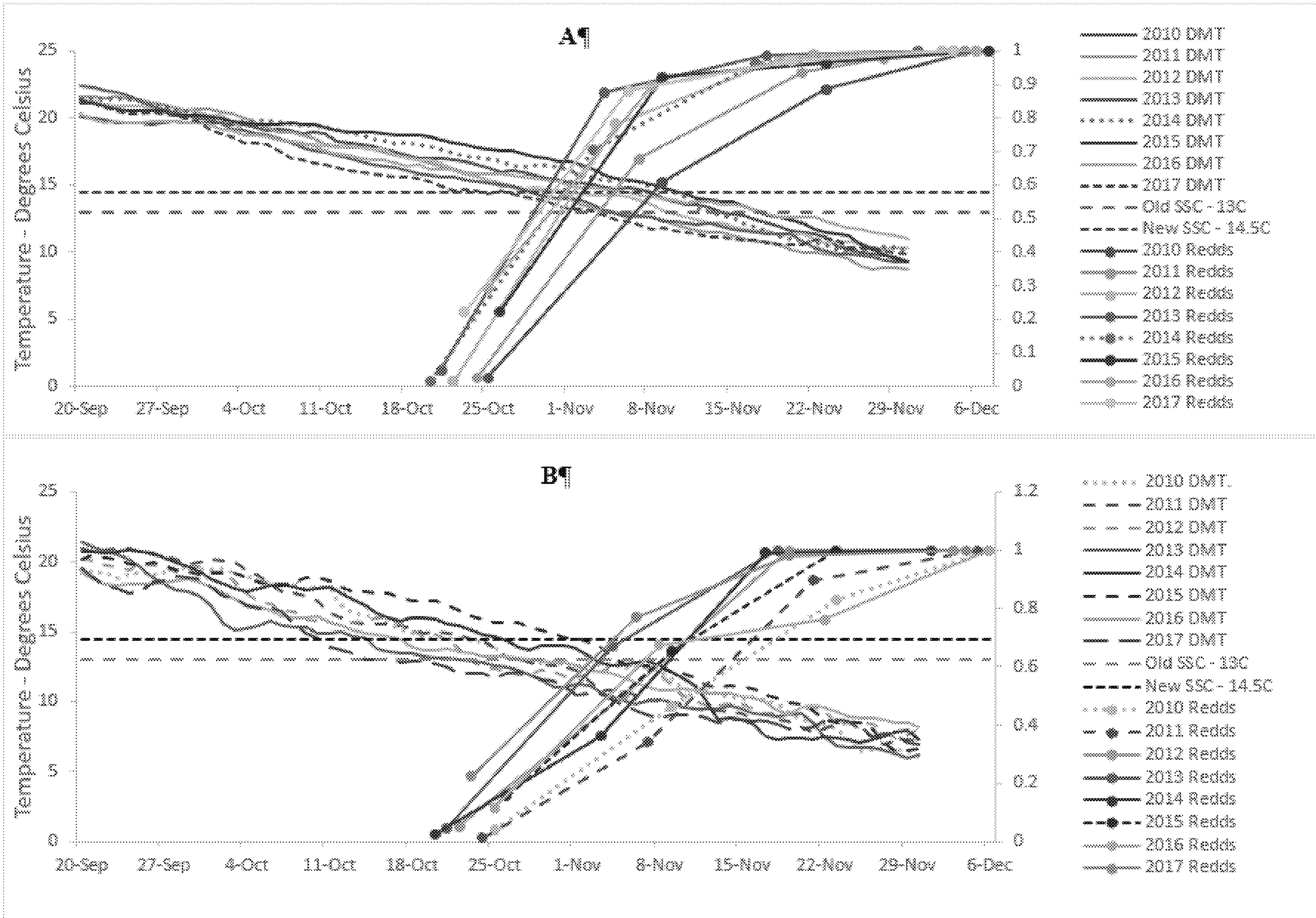


Figure 12. Average of the daily maximum temperatures recorded at six locations in the upper reach (A) and four locations in the lower reach (B) along with cumulative frequency of aerial redd counts for 2010-2017 (Data source: IPC 2019).

In addition, NMFS examined estimates of natural origin subyearling fall Chinook salmon at LGD (Tiffan et al. 2019) relative to temperatures experienced during the brood year. Stream temperatures in the Snake River for 2014 and 2015 were similar, yet the estimated natural-origin subyearlings at LGD were drastically different. The 2015 brood year experienced the highest instream temperatures since 2000 (Table 6), yet the number of natural origin subyearlings estimated at LGD for 2016 was the fourth highest since 2001. The highest estimate of natural origin subyearlings passing LGD occurred in 2015 (fish from brood year 2014). Incubation temperatures in the Snake River for that brood year (2014) were relatively high, with average daily maximum temperatures for the upper reach ranging between 15.3–17.2 during the October 23–November 6 time period. During 2014 and 2015, the proportion of redds in the upper reach relative to the mainstem Snake River were also similar (i.e., 61 and 74 percent, respectively), and the overall contribution of redds in the Snake River to the ESU was also similar (e.g., 42 and 34 percent, respectively) (Arnsberg et al. 2016, 2015; Chandler 2019). Overall, we did not observe consistent responses of cumulative frequency redd counts nor natural origin subyearling production to elevated water temperatures (Figure 13).

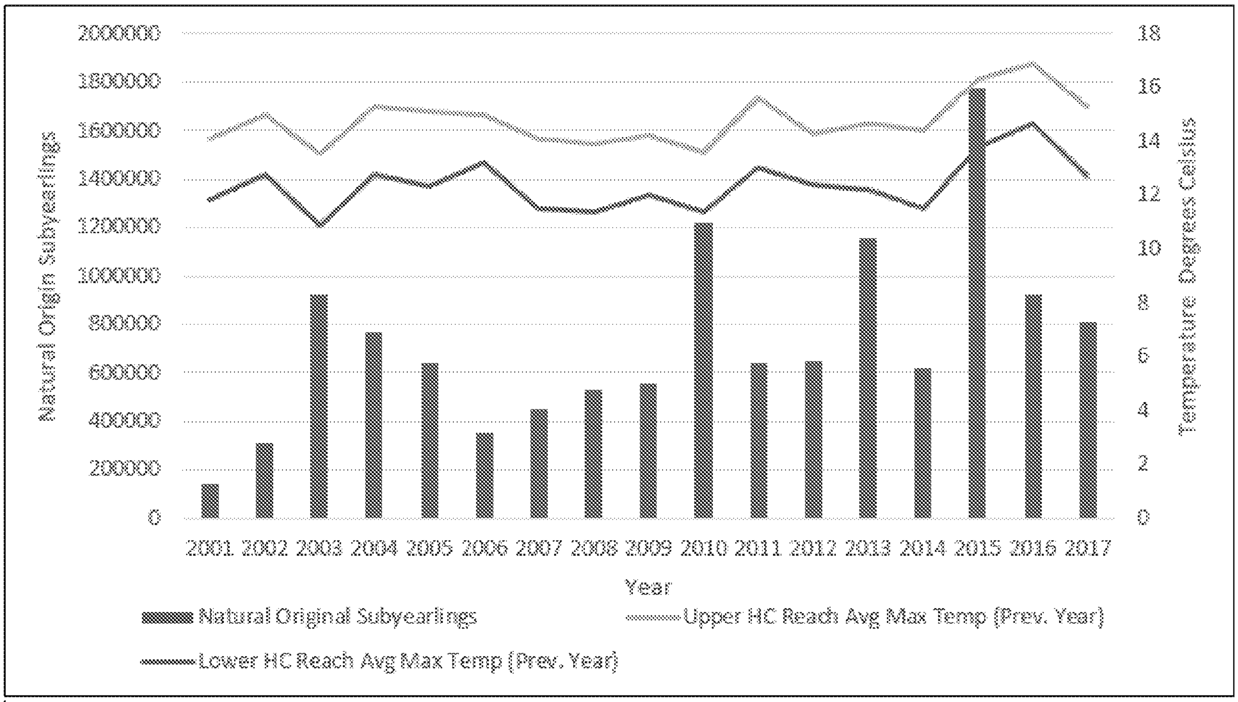


Figure 13. Estimates of natural origin subyearlings at LGD (Tiffan et al. 2019) and average maximum daily temperatures calculated for the upper and lower reaches of the Snake River for October 23–November 6. Temperatures for the previous year are aligned with the annual subyearling estimates to convey associated incubation temperatures.

Density dependence may be one potential reason as to why we were unable to discern a consistent response to temperature. Density dependence is known to be a factor influencing productivity in the mainstem Snake River (Connor 2013; Ford et al. 2011; NWFSC 2015; NMFS 2017a). Connor et al. (2016) reported that most of the available spawning habitat is used and that the habitat is approaching redd capacity. NMFS has noted that "The apparent leveling off of natural returns [of Snake River fall Chinook] in spite of the increases in total brood year spawners may indicate that density-dependent habitat effects are influencing production or that high hatchery proportions may be influencing natural production rates" (Ford 2011). Life cycle modeling efforts that are underway have found stronger evidence of density dependent mechanisms exerted at the spawning life stage, rearing life stage, and in predator-prey interactions (Peery et al. 2017; Tiffan et al. 2019). Further development of multi-stage life cycle models will produce insights into potential density-dependent effects as a function of environmental conditions (e.g., temperature) and will provide a better understanding of the degree to which these factors influence productivity of Snake River fall Chinook salmon.

Construction of the dam complex created a thermal shift to warmer fall and winter temperatures in the upper and lower Hells Canyon reaches. Water temperatures in the upper reach are now similar to what was historically observed in the Glenns Ferry reach of the Snake River, which produced the bulk of Snake River fall Chinook salmon (NMFS 2017a). Water temperatures since 2010 have been elevated above what was observed the previous twenty years. Even in light of these elevated temperatures, NMFS reduced the extinction risk of this species from moderate to low as a result of substantial improvements in abundance and productivity. However, NMFS (2017a) acknowledges there is substantial uncertainty about the species' productivity and ability to withstand environmental variation, such as that observed in 2015 when temperatures were exceedingly high in the action area.

2.5.2.4 Overall effects of the action to the population

To evaluate the degree to which the proposed action could impact Snake River fall Chinook salmon, NMFS considered the percent of the total redds counted annually (for the 2010–2017 time period) (Chandler 2019) in the upper and lower reaches during three specific thermal regimes (i.e., ≥17°C; 16.5– 16.9°C; and 14.5–16.4°C). We coupled this information with estimates of mortality described in Section 2.5.2.1 to quantify the potential effects of the proposed action. The available information provides conflicting information about the potential for adverse impacts to incubating embryos at temperatures equivalent to the SSC. To err on the side of the species, we have relied upon the Olson et al. (1970) mortality results for eggs incubated at temperatures of 14.8°C. It is conservative because the authors noted that while statistically significant differences in mortality were observed between control and lower test temperatures, the 11 percent overall mortality (which was recorded for the embryos incubated at initial temperatures of 14.8 °C) compares favorably with the average mortalities at USFWS fall Chinook rearing stations at Spring Creek and Little White Salmon on the Lower Columbia. For incubation temperatures between 16.5–16.9°C and greater than 17°C, we relied mortality estimates reported by Olson et al. (1970) and Geist et al. (2006), respectively.

Table 8 summarizes the estimated proportion of redds counted during these thermal regimes. Because the proposed criterion allows for these maximum daily temperatures to occur, we have assumed that past spawning at these temperatures is representative of what may occur in the future. In addition, the existing criterion also allows for temperatures to reach these levels.

However, rather than attempting to quantify the difference in effect between the proposed criterion and the existing criterion, we have assumed that all of the calculated effects are entirely reflective of the proposed action. This is a conservative approach and effects of the proposed action are likely less than what we have estimated here. Stream temperatures used for this analysis included the average of the daily maximum temperatures observed at four and six monitoring stations in the lower and upper reaches, respectively. Our results here are different from those presented in Conner (2015) due to the maximum temperature data used.

Table 8. Estimated annual proportion of redds counted for specified maximum daily temperature intervals and the associated estimates of average percent mortality.

Year	Upper Reach: % of Total Redd Counts			Lower Reach: % of Total Redd Counts		
	≥17°C	16.5–16.9°C	14.5–16.4°C	17°C	16.5–16.9°C	14.5–16.4°C
2010	1.3	0.9	50.9	0	0	3.0
2011	0.6	0.6	33.9	0	0	1.1
2012	0.7	0.5	55.1	0	0	4.6
2013	0.6	1.2	44.4	0	0	0.6
2014	26.0	9.9	47.5	0.3	0.3	14
2015	42.4	15.0	35.2	3.9	3.9	29.1
2016	0	7.3	69.3	0	0	0
2017	0	0	26.8	0	0	0
Average % of Redds Counted	4.2	2.9	46.9	0.1	0	3.3
Estimated Average % Mortality[1]	4.1	0.7	3.0	0.05	0.01	0.21

[1]Average percent mortality estimates were calculated by multiplying the reported percent mortalities associated with each thermal regime by the average percent of redds constructed for each thermal regime. The percent mortality associated with each thermal regime is as follows: ≥17°C (98 percent mortality estimate [Olson et al. 1970]); 16.5–16.9°C (23.6 percent mortality estimate [Olson et al. 1970]); and 14.5–16.4 (6.4 percent mortality estimate [Geist et al. 2006]).

Overall, when considering the proportion of redds that the upper and lower reaches contribute to the total redds within the action area, the proposed action could potentially impact an average of 40 percent of the redds constructed within the action area. Meaning, on average, based on data collected since 2010, an average of 40 percent of the redds were constructed when stream temperatures were above 14.5°C. Because different effects thresholds were utilized for the three assigned thermal regimes, estimates of percent mortality had to first be calculated for each thermal regime and year pairing in order to calculate an overall estimate of mortality. Ultimately, NMFS estimates that the proposed action could result in the loss of up to 8 percent of the redds in the mainstem Snake River based on past spawn timing. As described above, we have conservatively assumed this impact is relative to what may occur if the existing temperature criterion was achieved. Between 2010–2017, the proportion of redds in the action area comprised an average of 42 percent (ranging between 31–57 percent) of the total ESU redds. As such, the proposed action could result in the loss of an average of 3.4 percent of the ESU redds (ranging between 2.5–4.6 percent).

As described in the previous section, density dependent mechanisms are occurring at the spawning and rearing life stages. NMFS (2017a) developed a spawner-recruit relationship for Snake River fall Chinook using the Beverton Holt model. The model-fitting and selection process is described in the recently published Snake River fall Chinook Recovery Plan (NMFS 2017a). The relationship is density-dependent, meaning, that as you increase the number of spawners, a point is reached where the number of recruits per spawner levels off (Figure 14). As such, at lower spawner abundance, the impact of reduced egg-to-fry survival will be greater than that which occurs at higher spawner abundance. Recent research suggests that spawning habitat is nearing capacity, even though stream temperatures are greater than the existing criterion and proposed SSC.

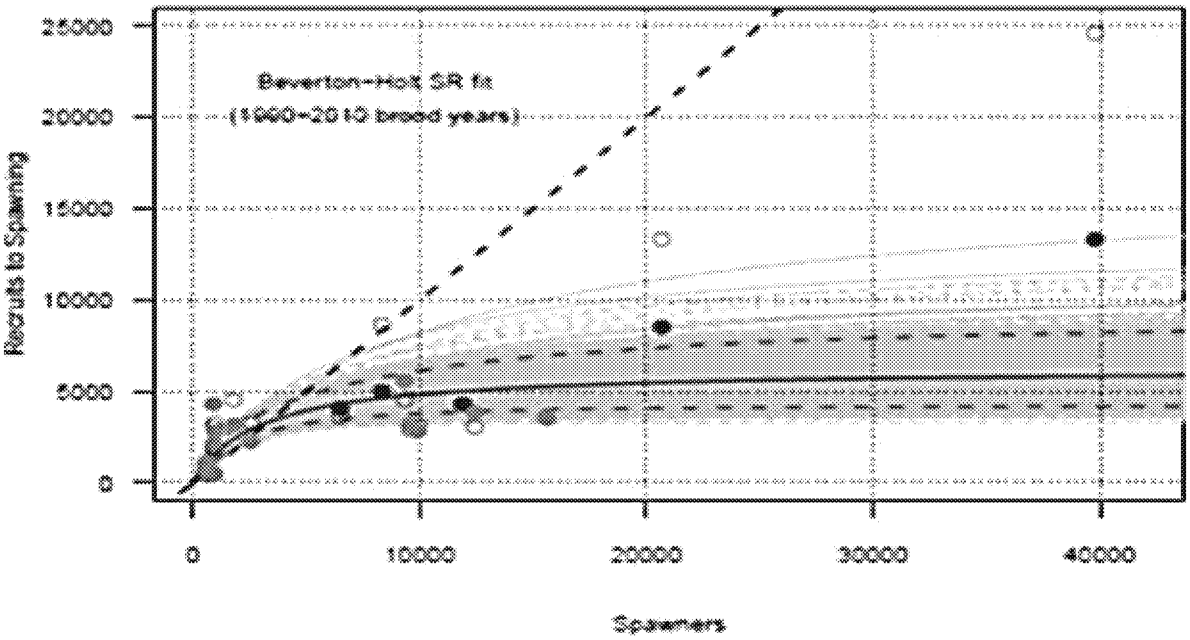


Figure 14. Beverton Holt stock recruit relationship fitted to brood years 1991–2010 Snake River fall Chinook adult escapement estimates. Data points (with and without average Pacific Decadal Oscillation multiplier). Gray lines represent range in parameter combinations from bootstrap iterations. Solid line: median relationship. Red dashed lines are 90 percent confidence range. Dashed black line is replacement.

Assuming each spawner in the population has the same fecundity, fertilizes the same number of redds, and has the same reproductive success and assuming that each redd produces the same number of offspring, a loss of 3.4 percent of the redds equates to 3.4 percent fewer returning adults each year. Using the Beverton Holt equation underlying the relationship depicted in Figure 14 (NMFS 2017a), we can calculate the number of adult recruits under the existing conditions vs. the number of adult recruits under the proposed SSC (with 3.4 percent fewer spawners), and then calculate the difference. Since the relationship is density-dependent (meaning that as you increase the number of spawners, you reach a point where the number of recruits per spawner starts to level off), the difference in the number of recruits under each scenario has to be calculated under a wide range of spawner abundances.

After going through the above steps, the results demonstrated that depending on the number of returning spawners, the proposed action could reduce the number of adult recruits by as few as five fish and by as many as 73 Chinook salmon per year. It should be noted that our analysis is conservative in that we assume there is no loss of redds (and no loss of spawners by extension) under the existing criterion. That assumption is conservative, because technically the existing criterion allows stream temperatures to exceed 14.5°C on the days preceding its period of applicability (see Section 2.5.1 and Table 1). Furthermore, our analysis does not include hatchery fish which return as adults to the hatchery facilities but do not spawn naturally. These fish are also part of the ESU, but their production is not affected by the proposed action. If these returning hatchery fish were included in the effects analysis, the calculated percentage of lost "production" for the ESU as a whole (including hatchery production) would be much smaller.

In summary, our above estimates of potential loss of fall Chinook salmon redds are conservative because the estimated proportion of redds potentially affected are based on what has been observed recently, during periods of time when stream temperatures are elevated above the proposed SSC. It stands to reason that if the mainstem Snake River were to comply with water quality criteria in the action area, then fewer redds would be constructed when temperatures are greater than 14.5°C. Furthermore, our estimates of potential loss of adult recruits is conservative because: (1) It assumes that the achieving the existing temperature criterion would not contribute to a loss of adult recruits; and (2) It does not account for all of the hatchery production that is included in the ESU. Considering this, and considering the line of evidence provided by fall Chinook salmon spawning in the Hanford reach coupled with the recent change in Snake River fall Chinook salmon viability, NMFS does not believe the small degree to which the proposed action could affect egg-to-fry survival will measurably reduce the overall production of the population.

2.5.3 Effects on Designated Critical Habitat

The entire mainstem Snake River within the action area is designated critical habitat for Snake River fall Chinook salmon. Table 4 summarizes the PBFs necessary to support freshwater spawning, rearing, and migration. The only PBF that the proposed action will affect is water temperature. As previously described, EPA is proposing to approve a site-specific temperature criterion that applies from October 23–November 6 and that is greater than the existing criterion by 1.5°C. This proposal will result in greater water temperatures during the early spawning time periods as well as during adult migration and holding time (Table 7) relative to the existing criterion. As described in Section 2.5.2, elevated temperatures could increase prespawn mortality, reduce gamete viability, and reduce egg-to-fry survival. Based on this information, the conservation value of the temperature PBF is expected to be diminished for a short period of time (i.e., between late September/early October through the first week of November) throughout the action area, although the effects are expected to be more pronounced in the upper reach.

2.5.4 Effects of Climate Change

The proposed action will remain in place and be applied to CWA programs (e.g., 401 certification of the HCC FERC license; TMDL implementation; etc.) in perpetuity, or until a new criterion is proposed for EPA approval. Thus, our analysis of effects for Snake River fall Chinook salmon and its designated critical habitat extends from the date of this Opinion for as long as the SSC remains effective. Because the proposed action establishes a SSC that serves as an upper threshold on allowable temperatures, climate change is not expected to amplify the effects of the proposed action. Rather, climate change is expected to make it more difficult to achieve the SSC into the future.

2.6 Cumulative Effects

"Cumulative effects" are those effects of future state or private activities, not involving federal activities, that are reasonably certain to occur within the action area of the federal action subject to consultation (50 CFR 402.02). Future federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA. An example of a future federal action includes the FERC relicensing of the HCC.

There are no known ongoing or planned non-federal, state or private activities, either nearby or upstream of the action area that would positively affect Snake River fall Chinook salmon habitat quality in the action area. Nonfederal actions occurring upstream or within the action area that will continue to impact habitat conditions include water withdrawals (i.e., those pursuant to senior state water rights) and land use practices. With the basin lands being primarily held by federal (47 percent), private (40 percent) and state (12 percent) landowners, few major changes to land use or land use practices are expected. A large proportion of the private land is used for hay production and livestock grazing. Timber has been harvested on many of the state and private forest lands in the basin, and this is also likely to continue into the future. The drainage includes two urban areas (i.e., Lewiston and Clarkston) at the confluence of the Clearwater and Snake Rivers; however, the vast majority of the area is undeveloped with few scattered rural communities. Population growth is expected in the urban areas; however, the rate of growth is expected to be small. The Clearwater Lewiston Paper Mill, the only industrial pollution source in the area, discharges treated effluent into the Snake River, but is located at the lower end of the action area.

Some continuing nonfederal activities are reasonably certain to contribute to climate change effects within the action area. However, it is difficult, if not impossible, to distinguish between the action area's future environmental conditions caused by global climate change that are properly part of the environmental baseline versus cumulative effects. Therefore, all relevant future climate-related environmental conditions in the action area are described in the environmental baseline.

The cumulative effects may continue to have some adverse effects on Snake River fall Chinook populations and their critical habitat PBFs. Many of these effects are activities that occurred in the past and were included in the environmental baseline. Some of these activities are considered reasonably certain to occur in the future because they occurred frequently in the recent past (especially if authorizations or permits have not yet expired), and have been addressed as cumulative effects. We anticipate that land use activities will continue to have adverse effects on listed species. We also expect that future harvest activities and hydropower operations will continue to have adverse effects on listed species in the action area. Looking to the future, we do not anticipate any major changes to current conditions in the action area.

2.7 Integration and Synthesis

The Integration and Synthesis section is the final step in our assessment of the risk posed to species and critical habitat as a result of implementing the proposed action. In this section, we add the effects of the action (Section 2.5) to the environmental baseline (Section 2.4) and the cumulative effects (Section 2.6), taking into account the status of the species and critical habitat (Section 2.2), to formulate the agency's Opinion as to whether the proposed action is likely to: (1) Reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) appreciably diminishes the value of designated or proposed critical habitat for the conservation of the species.

2.7.1 Snake River fall Chinook salmon

Snake River fall Chinook salmon experienced substantial improvements in their abundance and productivity through 2015. This led NMFS to reduce the ESU's risk of extinction from moderate to low (NMFS 2016a). Even in light of this reduction in extinction risk, the species remains listed as threatened due, in part, to the uncertainty surrounding our limited understanding of natural productivity relative to the high proportions of hatchery-origin spawners. In addition, there is uncertain about the ability of the ESU to withstand environmental variation, including elevated temperatures in migratory and spawning habitat and/or poor ocean conditions. The remaining risk factors of most importance to this species include: (1) Blocked access to historic spawning areas resulting in a single, remaining population; (2) relatively high harvest rates; (3) long-term risk relating to high levels of hatchery-origin fish spawning in each of the major spawning areas; (4) continuing mortalities due to dams and reservoirs in the mainstem migration and rearing corridor; (5) continued degraded conditions in tributary spawning and rearing areas; and (6) degraded, but somewhat improving conditions in the Columbia River estuary. The recovery plan identified a preferred recovery strategy that emphasizes natural production within the action area. As such, ensuring the action area can provide suitable spawning habitat of sufficient quantity and quality is of utmost importance to recovery. By reducing the hatchery influence in the action area, it will be possible in the future to gain a better understanding of the productivity of natural fish and the degree to which water temperatures influence that productivity.

The existing environmental baseline in the mainstem Snake River is degraded and characterized by elevated water temperatures, low dissolved oxygen, elevated contaminant concentrations, and altered flow regimes. Operation of the HCC and land use practices in watersheds upstream of the action area have had the greatest impact on instream habitat quality. Voluntary improvements in HCC operations have reduced juvenile entrapment and maintained stable flows during spawning and incubation, however it is unknown whether or for how long these actions will continue.[5] In addition, some components of the SRSP have been implemented to date in an effort to reduce stream temperatures and improve water quality in the Snake River. The HCC has altered stream temperatures downstream of the Hells Canyon Dam such that temperatures take longer to cool off in the fall and stay warmer during the incubation period relative to historic conditions. The highest WMT in the upper reach during October 23 through November 6 has exceeded 14.5°C every year since as early as 2000. Temperatures in the lower reach are cooler, due to the inflow of the Salmon River. For this lower reach, 9 of the 18 years experienced WMT greater than 14.5°C.

[5] These improvements have likely had a positive effect on the status of the species (productivity and abundance). They will likely be considered in a future consultation on FERC's issuance of a license for the HCC.

The environmental baseline reflects impacts from existing federal and non-federal land use activities on ESA-listed species. Current levels of these uses are likely to continue into the future and are unlikely to be substantially more severe than they currently are. The operations of the HCC will continue to affect Snake River fall Chinook salmon within the action area as described in the Status and Environmental Baseline sections (altered flows, altered thermal regimes, etc.). The ODEQ and IDEQ water quality certifications require the IPC comply with the 2004 TMDL thermal load allocation within 30 years after the date that FERC issues a new license for the HCC. Conditions required by the water quality certifications will be incorporated into the FERC license, which will be subject to a separate, future ESA consultation. NMFS has recently approved changes in tribal and non-tribal harvest of natural origin Snake River fall Chinook salmon adults. Harvest levels will be managed proportional to the total returning natural origin adults, with total harvest rates ranging from 6–20 percent of the total run size at Lower Granite Dam. In addition, there has been a recent change in the release location of one million hatchery fish from the upper reach to the Salmon River. The effects of these changes to the Snake River fall Chinook harvest and management strategies have yet to be realized. The change in release location of hatchery fish should contribute to an increase in abundance and productivity for this population in the long-term (NMFS 2018b). The recently approved fall Chinook recreational fishery is expected to have a small effect on the population; however, it is not anticipated to preclude ESU recovery.

The status of Snake River fall Chinook salmon is also likely to be affected by climate change. The ongoing impacts of climate change are reflected in the environmental baseline. In addition to the direct effects of rising temperatures, indirect effects include alterations in stream flow patterns in freshwater and changes to food webs in freshwater, estuarine, and marine habitats. There is high certainty that predicted physical and chemical changes will occur; however, the ability to predict bio-ecological changes to fish or food webs in response to these physical/chemical changes is extremely limited, leading to considerable uncertainty. As we continue to deal with a changing climate, management actions may help alleviate some of the potential adverse effects (e.g., hatcheries serving as a genetic reserve and source of abundance for natural populations, increased riparian vegetation to control water temperatures, etc.). Although climate change is not expected to amplify the effects of the proposed action, it is expected to make it more difficult to achieve the SSC into the future.

All life stages of Snake River fall Chinook salmon are present in the action area; however, only the adult holding, spawning, and early life stages are anticipated to be affected by the proposed action. The proposed action entails increasing the spawning temperature criterion from 13°C to 14.5°C for a 2-week period (i.e., October 23–November 6). As described in Section 2.5.1 of this Opinion, this will result in allowable stream temperatures that are 1.5°C greater (relative to allowable temperatures associated with the 13°C criterion) between approximately September 23 and October 29 each year. Our analysis in Section 2.5.2 has shown that the proposed SSC may adversely affect Snake River fall Chinook salmon by reducing gamete viability and reducing egg-to-fry survival. In order to estimate the potential mortality that may occur as a result of implementing a 14.5°C SSC, NMFS estimated the cumulative percent redd counts at various temperatures found to result in egg and/or egg-to-fry mortality. As described in

Section 2.5.2.4, we estimated that, on average, roughly 8 percent of the redds in the action area could be lost if constructed during times when stream temperatures were at their maximum allowable value. Rolling this estimate up to the ESU-level, this equates to an average loss of 3.4 percent of the total redds constructed within this ESU relative to what we'd expect to occur under the existing SSC (i.e., 13°C). The impact to the ESU will in actuality be much smaller than this because our analysis does not account for the hatchery production that is part of the ESU. A substantial number of protected hatchery fish are released into the Snake River basin above LGD and contribute juvenile fish to the population (some of which also return as adults to the spawning grounds as part of the current recovery strategy). The proposed action will not affect the juvenile hatchery fish that are released into the lower reaches of the action area.

Our estimate of temperature-related mortality (i.e., 2.5–4.5 percent) is likely overly conservative because it is based on the percent of redds constructed under existing temperature regimes (which are greater than those that would exist when the proposed SSC is achieved) and because they do not account for the entire hatchery production that is part of the ESU. Available data suggest that temperatures observed over the past 10 years are not precluding recovery of the species. Redd counts the past 10 years have been among the highest on record and estimated natural origin subyearling fall Chinook salmon at LGD have also been among the highest during this time period. Furthermore, abundance and productivity of the Hanford Reach population of fall Chinook salmon do not appear to be substantially impacted by temperatures similar to those that would occur under the proposed action. Considering the various lines of evidence summarized above, it is NMFS' Opinion that the proposed action is not likely to reduce appreciably the likelihood of both survival and recovery of Snake River fall Chinook salmon.

2.7.2 Snake River fall Chinook salmon designated critical habitat

The rangewide status of critical habitat designated for Snake River fall Chinook salmon is discussed in Section 2.2.2 of this opinion. Across much of the designated area, land use activities have disrupted watershed processes, reduced water quality, and diminished habitat quantity, quality, and complexity. Past and/or current land use or water management activities have adversely affected the quality and quantity of riparian conditions and side channels, floodplain function, sediment conditions, and other water quality and quantity parameters. As a result, the important watershed processes and functions that once created healthy ecosystems for fall Chinook salmon production have been weakened. Important exceptions to this include the alteration of operations at Dworshak and Hells Canyon Dam to protect spawning, rearing, and migratory conditions.

The mainstem Snake River below Hells Canyon Dam area is designated critical habitat for Snake River fall Chinook. The action area contains two of the five major spawning areas for this ESU. As previously described, the existing environmental baseline in the mainstem Snake River is degraded and characterized by elevated water temperatures, low dissolved oxygen, elevated contaminant concentrations, and altered flow regimes. Operation of the HCC and land use practices in watersheds upstream of the action area have had the greatest impact on instream habitat quality. Improvements in HCC operations (i.e., stabilization of outflow at the Hells Canyon Dam) protected existing spawning and early rearing habitat. The HCC has altered stream temperatures downstream of the Hells Canyon Dam such that temperatures take longer to cool off in the fall and stay warmer during the incubation period relative to historic conditions. The highest WMT in the upper reach during October 23 through November 6 has exceeded 14.5°C every year since as early as 2000. Temperatures in the lower reach are cooler, due to the inflow of the Salmon River. For this lower reach, 9 of the 18 years experienced WMT greater than 14.5°C.

The environmental baseline reflects impacts from existing federal and non-federal land use activities on designated critical habitat. Current levels of these uses are likely to continue into the future and are unlikely to be substantially more severe than they currently are. The future operations of the HCC will continue to affect critical habitat within the action area as described in the Status and Environmental Baseline sections (altered flows, altered thermal regimes, etc.). However, as described earlier, we expect habitat quality in the action area will improve over time as the IPC implements environmental protection programs.

Habitat conditions in the mainstem Snake River are likely to be affected by climate change. The ongoing impacts of climate change are reflected in the environmental baseline and are expected to continue into the future. In addition to the direct effects of rising temperatures, indirect effects include alterations in stream flow patterns in freshwater and changes to food webs in freshwater, estuarine, and marine habitats. There is high certainty that predicted physical and chemical changes will occur; however, the ability to predict bio-ecological changes to fish or food webs in response to these physical/chemical changes is extremely limited, leading to considerable uncertainty. As we continue to deal with a changing climate, management actions may help alleviate some of the potential adverse effects (e.g., hatcheries serving as a genetic reserve and source of abundance for natural populations, increased riparian vegetation to control water temperatures, etc.). Although climate change is not expected to amplify the effects of the proposed action, it is expected to make it more difficult to achieve the SSC into the future.

The proposed action is expected to only impact the water temperature PBF in two of the five major spawning reaches for the ESU. As previously described, EPA is proposing to approve a SSC that applies from October 23–November 6 and that is greater than the existing criterion by 1.5°C. The proposed action will allow for higher water temperatures during the early spawning period as well as during adult migration and holding times than what would occur if the existing SSC were met. These elevated water temperatures will diminish the conservation value of the temperature PBF in the action area, relative to the existing SSC. However, existing data suggest that the degree to which temperatures are elevated relative to existing SSC should not impede the ability of the action area to support successful spawning and incubation of Snake River fall Chinook salmon. Thus at the scale of the designation, it is NMFS' Opinion that the proposed action will not appreciably reduce the value of designated critical habitat for the conservation of Snake River fall Chinook salmon.

2.8 Conclusion

After reviewing and analyzing the current status of the listed species and critical habitat, the environmental baseline within the action area, the effects of the proposed action, any effects of interrelated and interdependent activities, and cumulative effects, it is NMFS' Opinion that the proposed action is not likely to jeopardize the continued existence of Snake River fall Chinook salmon and is not likely to destroy or adversely modify its designated critical habitat.

2.9 Incidental Take Statement

Section 9 of the ESA and federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. "Harm" is further defined by regulation to include significant habitat modification or degradation that actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering (50 CFR 222.102). On an interim basis, NMFS interprets "harass" to mean "Create the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering." "Incidental take" is defined by regulation as takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the federal agency or applicant (50 CFR 402.02). Section 7(b)(4) and section 7(o)(2) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this ITS.

2.9.1 Amount or Extent of Take

While the proposed action itself (i.e., EPA approval of the SSC) will not result in incidental take, implementation of the SSC in regulatory programs under the CWA (e.g., 401 certification, discharge permits, TMDL) is reasonably certain to result in incidental take of ESA-listed species. NMFS is reasonably certain the incidental take described here will occur because: (1) Mortality of embyros at temperatures authorized by the SSC have been documented in scientific literature; (2) adult fall Chinook salmon migrate, hold, and spawn in areas where the SSC applies; and (3) embryos incubate and develop in areas where the SSC applies. Because the SSC authorizes a 1.5°C increase in stream temperatures (relative to the current criterion) between late September and late October, the adult and early life stages of Snake River fall Chinook salmon may be affected.

The SSC is a rolling 7DADM temperatures. As such, it allows for maximum daily temperatures to exceed 14.5°C on the days leading up to October 29. As described in Section 2.5.1, maximum daily temperatures could be equivalent to 18.1°C on October 8, assuming an average daily decline in temperatures of 0.2°C. Existing literature demonstrates embryo mortality occurs at these elevated temperatures. It is not possible to count the number of embryos that fail to develop into fry as a result of exposures to elevated temperatures; therefore, a surrogate for the extent of take is necessary. It is possible to monitor the number of redds that are constructed when stream temperatures are above the threshold thought to adversely affect embryo survival; therefore redd counts may be a useful surrogate for the extent of take. Because the number of redds can vary drastically between years and is influenced by out-of-basin factors, we have chosen to use an estimate of the percent of redds constructed when temperatures are above the SSC as means for quantifying take. The estimated percent of redds constructed during elevated temperatures is directly related to the number of embryos that may be impacted by exposures to elevated temperatures. In Section 2.5.2.4 of the Opinion, NMFS estimated the annual loss of redds based on the product of the following: (1) Estimated percent of redds constructed within particular thermal regimes (i.e., $\geq$17°C, 16.5–16.9°C; and 14.5–16.4°C); and (2) estimates of percent mortality associated with the corresponding thermal regime. NMFS assumes that the historic average of the percent of redds constructed when maximum daily temperatures are greater than 14.5°C is representative of what will continue into the future. The historic average, calculated based on data from 2010–2017, was estimated to be about 40 percent of all the redds, the majority of which were constructed when temperatures were between 14.5–16.5°C. As such, our surrogate for the extent of take is equivalent to no more than 40 percent of all the redds, on average, being constructed when temperatures are elevated above 14.5°C.

2.9.2 Effect of the Take

In the Opinion, NMFS determined that the amount or extent of anticipated take, coupled with other effects of the proposed action, is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat.

2.9.3 Reasonable and Prudent Measures

"Reasonable and prudent measures" are nondiscretionary measures that are necessary or appropriate to minimize the impact of the amount or extent of incidental take (50 CFR 402.02). "Terms and conditions" implement the RPMs (50 CFR 402.14). These must be carried out for the exemption in section 7(o)(2) to apply.

NMFS believes the RPMs described below and their associated terms and conditions described in Section 2.9.4, are necessary and appropriate to minimize the likelihood of incidental take of ESA-listed species due to implementation of the proposed action.

The EPA and IDEQ shall:

1. Minimize the potential for adverse effects associated with implementation of the SSC; and

2. Ensure completion of a monitoring and reporting program to confirm that the terms and conditions of the ITS are effective in avoiding and minimizing incidental take from implementation of the proposed action and ensuring the amount of incidental take is not exceeded.

2.9.4 Terms and Conditions

The terms and conditions described below are non-discretionary, and the EPA and IDEQ must comply with them in order to implement the RPMs (50 CFR 402.14). The EPA and IDEQ have a continuing duty to ensure that the impacts of incidental take are monitored and must report the progress of the action and its impact on the species as specified in this ITS (50 CFR 402.14). If the EPA or IDEQ, to whom a term and condition is directed, does not comply with the following terms and conditions, protective coverage for the proposed action would likely lapse.

1. The following terms and conditions implement RPM 1:

   a. Consistent with IDEQ's regulations[6] and integrated reporting methods,[7] and the CWA[8] and its implementing regulations,[9] the IDEQ will apply the appropriate salmonid spawning criteria for the protection of any existing salmonid spawning use when and where the use is attained, such as in the portion of the mainstem Snake River from the confluence of the Salmon River to the confluence of the Clearwater River including the following segments of the Snake River: ID17060103SL004_08; ID17060103SL003_08; and ID17060103SL002_08, and ID17060103SL001_08. In the State's next triennial review, the IDEQ will review the available data and consider designating salmonid spawning in these segments through rulemaking. The IDEQ will share the data with EPA, establish a milestone in the next Performance Partnership Agreement (PPA) to provide updates of progress on its review, and provide such updates during the regular PPA check-ins.

2. The following terms and conditions implement RPM 2:

   a. The EPA and IDEQ shall share with NMFS the results of any temperature monitoring conducted within the mainstem Snake River that are reported as part of the 401 certification and/or FERC relicensing for the HCC[10].

   b. The EPA and IDEQ shall share with NMFS the results of any fall Chinook salmon spawning surveys conducted within the mainstem Snake River that are reported as part of the 401 certification and/or FERC relicensing for the HCC.[10]

   c. The EPA and IDEQ shall ensure NMFS receives a copy of the data collected in term and condition 2.a and 2.b above. The information shall be provided to NMFS annually, until such time as NMFS, EPA, and IDEQ agree reporting may cease.[11] The information shall include the following:

      i. Identification; location (i.e. latitude and longitude); and daily minimum, average, and maximum temperatures for each monitoring station.

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[6] Idaho Water Quality Standards (IDAPA 58.01.02.051.01): The existing in stream water uses and the level of water quality necessary to protect the existing uses shall be maintained and protected; and Idaho Administration Procedures Act (IDAPA) 58.01.02.050.02.b: In all cases, existing beneficial uses of the waters of the state will be protected.
[7] Water Body Assessment Guidance (IDEQ 2016).
[8] Consistent with the goal of the CWA to restore and maintain the chemical, physical, and biological integrity of the nation's waters (Section 101(a)).
[9] 40 CFR 131.12(a)(1): Existing instream water uses and the level of water quality necessary to protect the existing uses shall be maintained and protected.
[10] The IPC has conducted annual temperature and redd monitoring since as early as 1991. NMFS anticipates this monitoring will continue into the future. The final 401 water quality certification requires temperature monitoring in the Snake River.
[11] Annual reporting requirements are expected to be fulfilled in the future in association with the FERC relicensing consultation.

ii. Dates of spawning survey, redd counts, river mile, and survey gear (e.g. helicopter, unmanned aircraft, video, or ground).

b. The information described above shall be emailed to Ritchie Graves (Ritchie.Graves@noaa.gov) by January 31 (each annual report will be for the preceeding year) of each year following issuance of this Opinion. A reference to NMFS tracking number WCRO-2019-00175 shall be included in the submittal.

2.10 Conservation Recommendations

Section 7(a)(1) of the ESA directs federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. Specifically, conservation recommendations are suggestions regarding discretionary measures to minimize or avoid adverse effects of a proposed action on listed species or critical habitat or regarding the development of information (50 CFR 402.02).

1. To improve the quality of designated critical habitat and help advance the recovery of ESA-listed anadromous species in Idaho, the EPA should use all of its available authorities to ensure TMDL's are effectively implemented to reduce water quality impacts (especially temperature) from both point and nonpoint sources.

2. To improve the quality of designated critical habitat and help advance the recovery of ESA-listed anadromous species in Idaho, the EPA should use all of its available authorities to ensure point source discharges are employing the most effective treatment technologies available.

Please notify NMFS if the EPA, or another entity, carries out these recommendations so that we will be kept informed of actions that minimize or avoid adverse effects and those that benefit listed species or their designated critical habitats.

2.11 Reinitiation of Consultation

This concludes formal consultation for the EPA's proposed approval of Idaho's Snake River – Hells Canyon site-specific temperature criterion. As 50 CFR 402.16 states, reinitiation of formal consultation is required where discretionary federal agency involvement or control over the action has been retained or is authorized by law and if: (1) The amount or extent of incidental taking specified in the ITS is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this Opinion; (3) the agency action is subsequently modified in a manner that causes an effect on the listed species or critical habitat that was not considered in this Opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action.

When evaluating whether the amount of take has been exceeded, NMFS will apply the following principles. A single annual exceedance above the cumulative percentage threshold identified in Section 2.9.1 will not warrant reinitiation. This is consistent with the analysis in our Opinion, where data from 2015 was excluded. Rather, NMFS will consider whether multiple (3 or more), consecutive exceedances are occurring, coupled with information about whether the outfall temperatures at Hells Canyon Dam are improving over time.

2.12 "Not Likely to Adversely Affect" Determinations

The proposed action is described in Section 1.3 of this Opinion. The proposed action may affect Snake River spring/summer Chinook salmon, Snake River sockeye salmon, Snake River Basin steelhead, and their designated critical habitats. In addition, while the proposed action will not have any direct effects on SRKW, it may indirectly affect the species and designated critical habitat by reducing the quantity and quality of available prey. The listing status of each of these species, critical habitat designations and protective regulations are presented in Table 9. Impacts to these species and their designated critical habitats are described in Sections 2.13.1 through 2.13.4.

Table 9. Federal register notices for final rules that list threatened and endangered species, designated critical habitat, or apply protective regulations to listed species considered in this consultation.

Species	Listing Status	Critical Habitat	Protective Regulations
Chinook salmon (*Oncorhynchus tshawytscha*)			
Snake River spring/summer run	T 6/28/05; 70 FR 37160	12/28/93; 58 FR 68543 10/25/99; 64 FR 57399	6/28/05; 70 FR 37160
Sockeye salmon (*O. nerka*)			
Snake River	E 6/28/05; 70 FR 37160	12/28/93; 58 FR 68543	ESA Section 9 applies
Steelhead (*O. mykiss*)			
Snake River Basin	T 1/05/06; 71 FR 834	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Killer Whale *(Orcinus orca)*			
Southern Resident	E 11/18/05; 70 FR 69903	11/29/06; 71 FR 69054	4/14/11: 76 FR 20870

Note: Listing status 'T' means listed as threatened under the ESA; 'E' means listed as endangered.

2.12.1 Impacts to Snake River spring/summer Chinook salmon and its designated critical habitat

Snake River spring/summer Chinook occur within the action area, though not frequently during the months of October and November, when the proposed action is most influential. The Snake River spring/summer Chinook salmon ESU was originally listed as threatened on April 22, 1992 (57 FR 14653) and was reaffirmed as threatened under the ESA in 2005 (70 FR 37160). The Snake River spring/summer-run Chinook salmon ESU includes all naturally spawned populations of spring/summer-run Chinook salmon in the mainstem Snake River and the Tucannon River, Grande Ronde River, Imnaha River, and Salmon River subbasins, as well as 11 hatchery programs, all of which are included in the ESU (70 FR 20802). The EPA determined that the action as proposed may affect, but is not likely to adversely affect Snake River spring summer Chinook salmon.

Adult Snake River spring-summer Chinook have already completed their migration and have spawned by October of each year. Most Snake River spring-run Chinook can be found on spawning grounds from mid-to-late August and summer-run Chinook spawn approximately

1-month later and lower in the tributary drainages (NMFS 2017b). Juvenile spring-summer salmon exhibit a stream-type life history, and therefore they may be present in the action area in the summer and fall months while making extensive migrations from natal reaches into alternative summer-rearing or overwintering areas; however, the EPA's Temperature Guidance (2003) for general migration and rearing is 18°C, and 16°C for core rearing, both higher than the proposed 14.5°C SSC (EPA 2019). Most Snake River spring/summer Chinook salmon enter the action area in Hells Canyon in the spring months when they migrate to the ocean as yearlings (Figure 15).

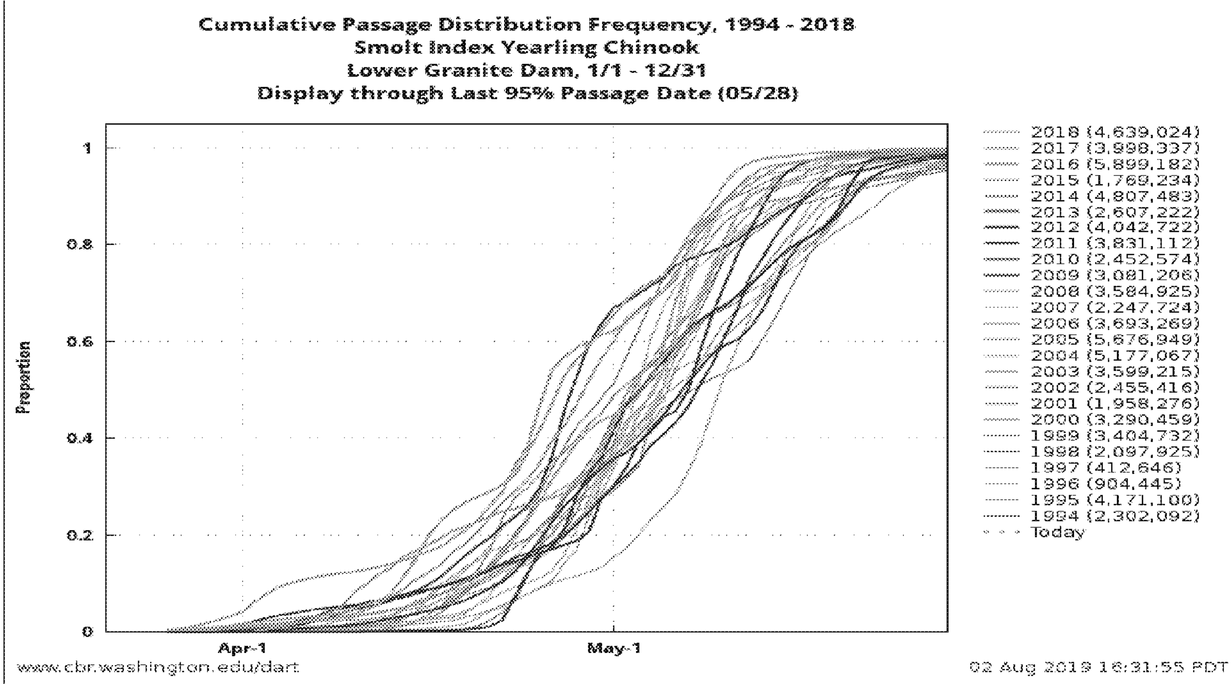

Figure 15. Proportion of yearling Chinook passing Lower Granite Dam by date (1994-2018).

Within the action area, the mainstem Snake River is designated critical habitat for Snake River spring/summer Chinook salmon. This area serves as a freshwater migration corridor for both adults and juveniles and may be used for some rearing by juveniles. The most relevant component of this critical habitat PBF which could be affected by the proposed action is water quality, more specifically, water temperatures between October 23rd to November 6th and up to 4 weeks leading up to this time period. Adult Snake River spring/summer Chinook salmon are not expected to be in the action area during the time at which effects from the proposed action will occur. Juvenile Snake River spring/summer Chinook salmon are also unlikely to be present in the action area when effects of the proposed action are prevalent. However, in the unlikely event that juveniles are present, they will likely seek cold water refuges during times when temperatures are allowed to be warmer than what is optimal for rearing. As such, effects to Snake River spring/summer Chinook salmon that may be exposed to elevated temperatures authorized by the proposed action are expected to be insignificant. Based on this analysis, NMFS concurs with the EPA that the proposed action is "not likely to adversely affect" Snake River spring-summer Chinook salmon and its designated critical habitat because the effects of the proposed action are insignificant.

2.12.2 Impacts to Snake River sockeye salmon and its designated critical habitat

Snake River sockeye salmon occur within the action area, but only a very small proportion of the population may be present during the proposed SSC dates (October 23rd–November 6^{th}) and in the preceding weeks. The Snake River sockeye salmon ESU was first listed as endangered under the ESA in 1991, and the listing was reaffirmed in 2005 (70 FR 37160). Before the turn of the twentieth century, large runs of sockeye salmon returned annually to the Snake River basin (Evermann 1895; Selbie et al. 2007). Sockeye salmon ascended the Snake River to the Wallowa River basin in northeastern Oregon and the Payette and Salmon River basins in Idaho to spawn in natural lakes. Today, the last remaining Snake River sockeye salmon are in the Sawtooth Valley of Idaho and, of the five lakes that formerly supported sockeye populations, only the Redfish Lake population remains. This population is supported by a captive broodstock program and conventional hatchery programs; reintroduction of captive broodstock progeny has included incorporating multiple releases into Redfish, Pettit, and Alturas Lakes. The Redfish Lake population migrates 900 miles each way, both downstream and upstream from Sawtooth Valley to the ocean through Salmon, Snake and Columbia Rivers and back again (NMFS 2015b). The EPA determined that the action as proposed may affect, but is not likely to adversely affect, Snake River sockeye salmon.

A large proportion of adult Snake River sockeye salmon pass through the action area and enter the Salmon River on their upstream migration before October of each year. According to the University of Washington Data Access in Real Time database, nearly all adult migrants were detected passing Lower Granite Dam before mid-September in the last 25 years, with the exception of one year (Figure 16). As discussed in the EPA's BE, Snake River temperatures, through which a small proportion of late-returning sockeye salmon would be migrating, could exceed the 16°C threshold (for impacts to ripe gametes) during the 2 weeks prior to October 23^{rd} (EPA 2019). Since the sockeye spend at least a month migrating to spawning grounds after entering the Salmon River, Snake River temperatures are not considered to be a threat to gamete viability (EPA 2019). Juvenile sockeye salmon smolts from Redfish Lake typically pass Lower Granite Dam from mid-May to mid-July and would therefore not be affected by the proposed action (Figure 17).

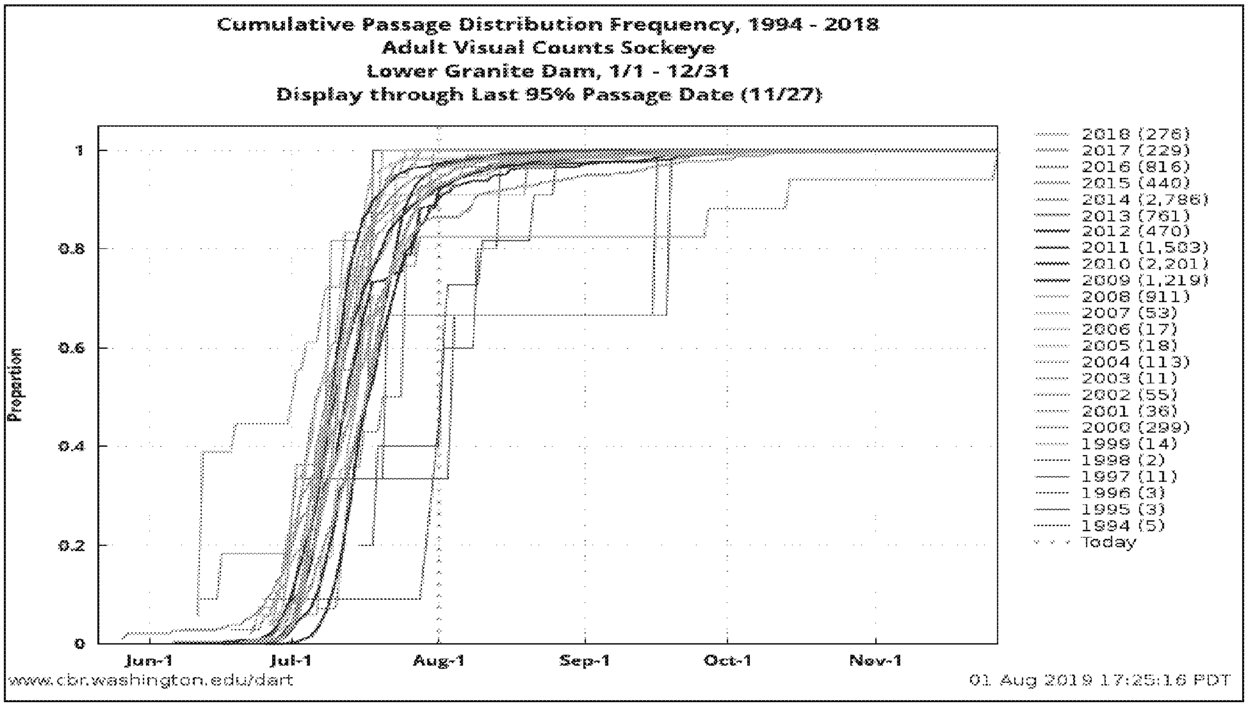

Figure 16. Cumulative proportion of adult Snake River sockeye salmon passage at Lower Granite Dam (1994–2018).

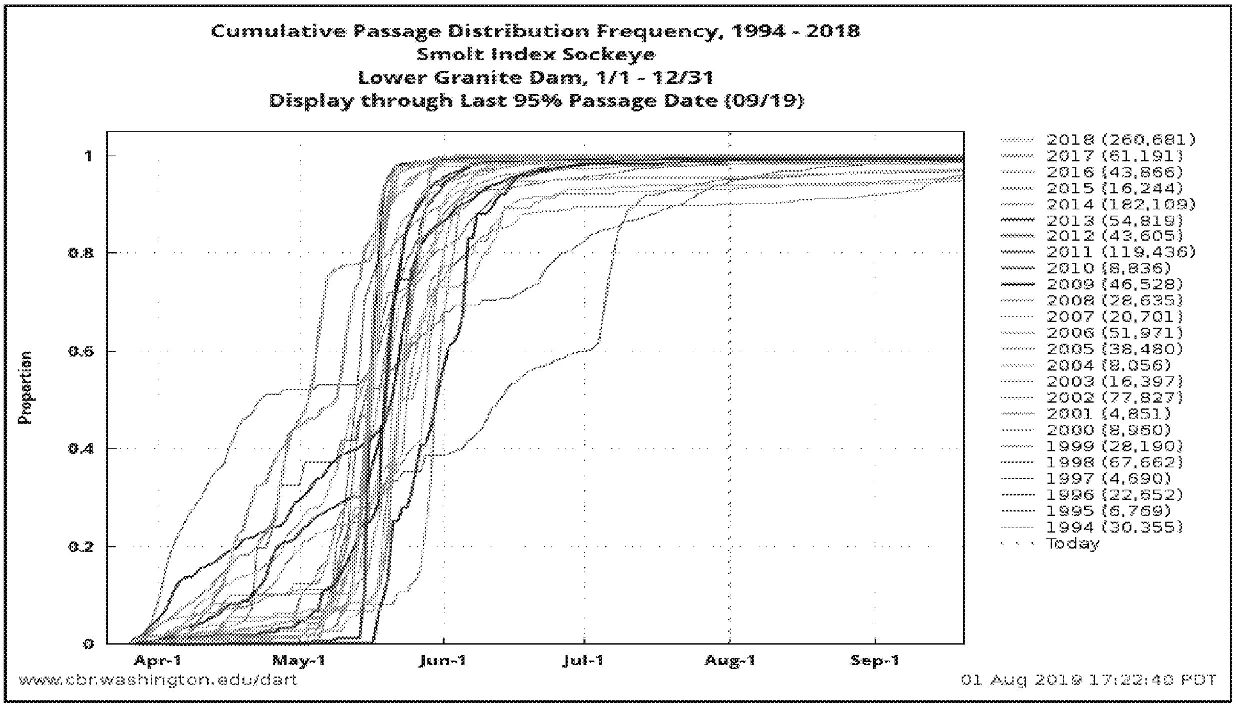

Figure 17. Cumulative proportion of Snake River sockeye salmon smolts passing Lower Granite Dam by date (1994–2018).

The effects of the proposed action will overlap with designated critical habitat for Snake River sockeye salmon on the mainstem Snake River between the Clearwater River confluence and the

Salmon River confluence. This area serves as a freshwater migration corridor for both adults and juveniles. The most relevant component of this critical habitat PBF that could be affected by the criteria changes is water quality, specifically water temperatures between October 23rd to November 6th and about 4 weeks leading up to this time period. Because the majority of sockeye salmon adults are expected to migrate through the action area prior to late-September, effects associated with any limited exposures to elevated temperatures authorized by the proposed action will be insignificant. Based on this analysis, NMFS concurs with the EPA that the proposed action is "not likely to adversely affect" Snake River sockeye salmon and its designated critical habitat because the effects of the proposed action are insignificant.

2.12.3 Impacts to Snake River Basin steelhead and its designated critical habitat

On August 18, 1997, NMFS listed the Snake River steelhead distinct population segment (DPS) as a threatened species (62 FR 43937). The threatened status was reaffirmed in 2006 (71 FR 834). The Snake River steelhead DPS includes all naturally spawned anadromous *O. mykiss* originating below natural and manmade impassable barriers in streams in the Snake River basin of southeast Washington, northeast Oregon, and Idaho. Twenty-four historical populations (an additional three are extirpated) within six major population groups, or MPGs (Grande Ronde River, the Imnaha River, the Clearwater River, the Salmon River and the Lower Snake) comprise the Snake River steelhead DPS. Inside the geographic range of the DPS, 12 hatchery steelhead programs are currently operational. Five of these artificial programs are included in the DPS.

Adult Snake River Basin steelhead are generally classified as summer-run, returning to the Snake River basin from late summer through fall, where they hold in larger rivers for several months before moving upstream into smaller tributaries. Snake River Basin steelhead spawn and rear across a wide range of freshwater temperature/precipitation regimes, but do not spawn in the action area or any part of the mainstem Snake River. However, much of the freshwater habitat used by Snake River steelhead for spawning and rearing is warmer and drier than that associated with other steelhead DPSs. Typically more than 90 percent of Snake River Basin steelhead arrive above LGD by November 1st, but approximately 2.1 percent of the adults remain below LGD over the winter and move upstream in the spring (April through June 20; Figure 18). Given this information, a portion of the adults in this DPS may move through or hold in the action area during the time of the proposed temperature criteria change. In addition, juvenile steelhead may be present in the action area during the time which effects of the proposed action are realized. The proposed action has no effect on steelhead smolts, which migrate out of the tributaries and into the action area between the end of March through mid-June (Figure 19).

However, as established in the EPA's BE of the site-specific criteria change proposed, Snake River steelhead start to experience adverse effects at river temperatures at or above 19°C, which is higher than temperatures that would be experienced in the action area under the new temperature criteria being proposed (14.5°C 7DADM from October 23rd to November 6th) (EPA 2019). Furthermore, both adult and juvenile steelhead will seek cold water refuges during times when temperatures are allowed to be warmer than what is optimal for holding or rearing.

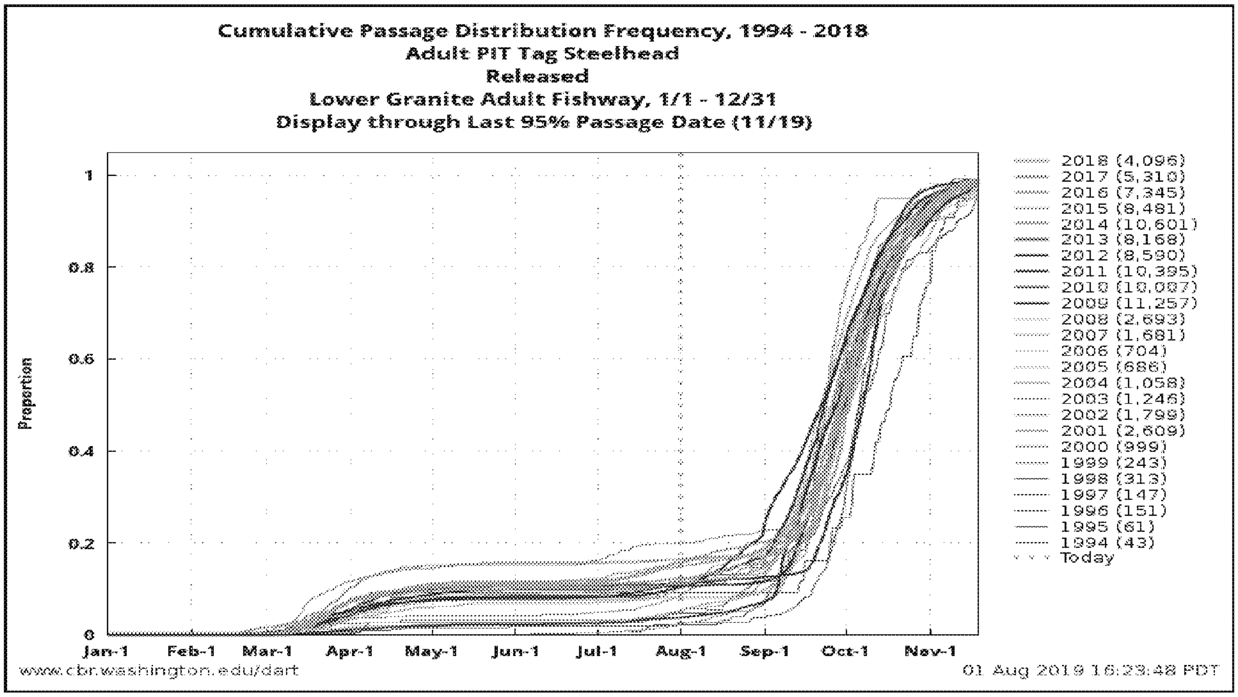

Figure 18. Cumulative proportion of adult Snake River steelhead passage at LGD (1994–2018).

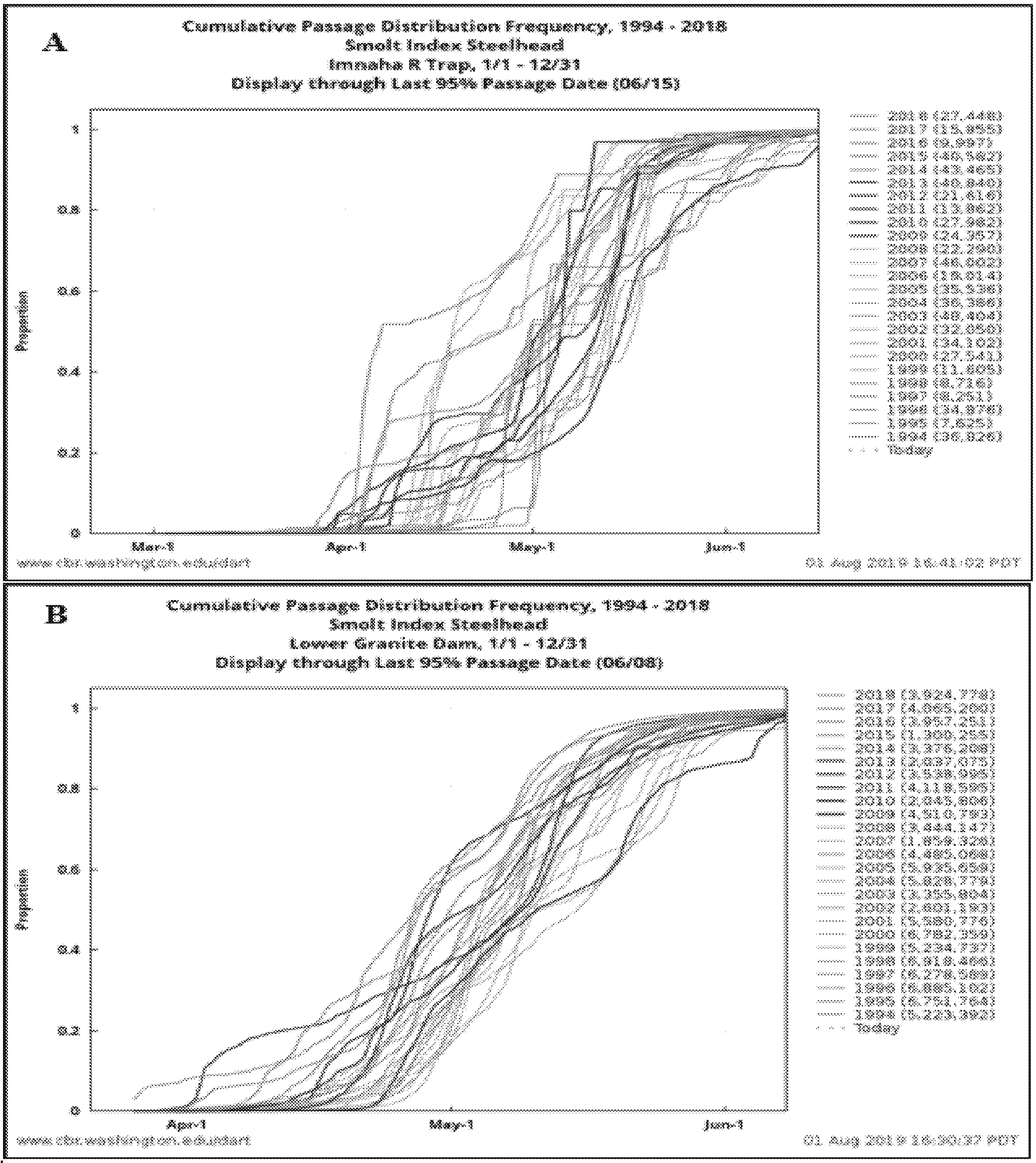

Figure 19. Cumulative proportion of steelhead smolts passing the Imnaha River trap (A) and LGD (B) by date (1994-2018).

The effects of the proposed action will overlap with designated critical habitat for Snake River steelhead on the mainstem Snake River between the Clearwater River confluence and Hells Canyon Dam. The PBF that may be affected by the proposed action is water quality (temperature) conditions between October 23rd to November 6th and for 4 weeks leading up to this time period.

Though a portion of Snake River steelhead adults and juveniles may be present in the action area during the time of the proposed action, any potential impacts to individuals from exposure to elevated temperatures are expected to be minor due to their tolerance for warmer temperatures, their ability to seek out cold-water refuges, and the fact that adults passing through the action area between mid-October and early November are still at least 4 months away from spawning season. Thus, NMFS concurs that the proposed action is not likely to adversely affect Snake River steelhead and its designated critical habitat because the effects of the proposed action are insignificant.

2.12.4 Impacts to SRKW and its designated critical habitat

On November 18, 2005, NMFS listed the SRKW DPS as endangered under the ESA (70 FR 69903) and a recovery plan was completed in 2008 (NMFS 2008b). NMFS completed a 5-year review in 2016, and concluded that Southern Residents should remain listed as endangered. That review includes recent information on the population, threats, and new research results and publications (NMFS 2016b). Critical habitat in inland waters of Washington was designated on November 29, 2006 (71 FR 69054).

The Southern Resident killer whale DPS is a single population which consists of three pods (J, K, and L) who inhabit coastal waters off Washington, Oregon, and Vancouver Island and are known to travel as far south as central California and as far north as Southeast Alaska (NMFS 2008b; Hanson et al. 2013; Carretta et al. 2017). During the spring, summer, and fall months, the whales have typically spent a substantial amount of time in the inland waterways of the Strait of Georgia, Strait of Juan de Fuca, and Puget Sound (Bigg 1982; Ford 2000; Krahn et al. 2002; Hauser et al. 2007; Hanson and Emmons 2010; Whale Museum 2003 unpubl. data). Although seasonal movements are generally predictable, there can be large inter-annual variability in arrival time and days present in inland waters from spring through fall, with late arrivals and fewer days present in recent years (Hanson and Emmons 2010; The Whale Museum 2003 unpubl. Data). During fall and early winter, SRKWs and J pod in particular, expand their routine movements into Puget Sound, likely to take advantage of chum, coho, and Chinook salmon runs (Osborne 1999; Hanson et al. 2010; Ford et al. 2016). All three pods generally remain in the Georgia Basin through October and make frequent trips to the outer coasts of Washington and southern Vancouver Island and are occasionally sighted as far west as Tofino and Barkley Sound (Ford 2000; Hanson and Emmons 2010; Whale Museum 2003unpubl. data).

In recent years, several sightings and acoustic detections of SRKWs have been obtained off the Washington and Oregon coasts in the winter and spring (Hanson et al. 2010; Hanson et al. 2013; NWFSC 2017 unpubl. data). Satellite-linked tag deployments have also provided more data on the SRWK movements in the winter indicating that K and L pods use the coastal waters along Washington, Oregon, and California during non-summer months. Detections rates of K and L pods on the passive acoustic recorders indicate SRKWs occur with greater frequency off the Columbia River and Westport and are most common in March (Hanson et al. 2013). J pod has also only been detected on one of seven passive acoustic recorders positioned along the outer coast (Hanson et al. 2013). The limited range of the sightings/acoustic detections of J pod in coastal waters, the lack of coincident occurrence during the K and L pod sightings, and the results from satellite tagging in 2012–2016 (NWFSC 2017 unpubl. data) indicate J pod's limited occurrence along the outer coast and extensive occurrence in inland waters, particularly in the northern Georgia Strait.

The final listing rule identified several potential factors that may have resulted in the decline of the SRKW or that may be limiting recovery of the species. These factors include: the quantity and quality of prey, toxic chemicals which accumulate in top predators, and disturbance from sound and vessel traffic. The rule also identified oil spills as a potential risk factor for the small population of SRKW. More information about these potential threats to the SRKW is included in the final recovery plan (NMFS 2008b).

NMFS has continued to fund the Center for Whale Research to conduct an annual census of the Southern Resident population. As of August 2019, two new calves have been reported and three adult whales have been reported dead. With the births and deaths reported so far this year, the Southern Residents total 73 individuals. The NWFSC continues to evaluate changes in fecundity and mortality rates, and has updated the work on population viability analyses conducted for the 2004 Status Review for SRKW (Krahn et al. 2004; Ward et al. 2013). Following from that work, the data now suggest a downward trend in population growth projected over the next 50 years. As the model projects out over a longer time frame (50 years) there is increased uncertainty around the estimates. The downward trend is in part due to the changing age and sex structure of the population, and will occur more frequently if the fecundity rates are lower (as in 2016) compared to the recent past (2011–2016) (Figure 20; NMFS 2016b). Recent evidence indicates pregnancy hormones (progesterone and testosterone) can be detected in SRKW feces and have indicated several miscarriages, particularly in late pregnancy (Wasser et al. 2017). The authors suggest this reduced fecundity is largely due to nutritional limitation.

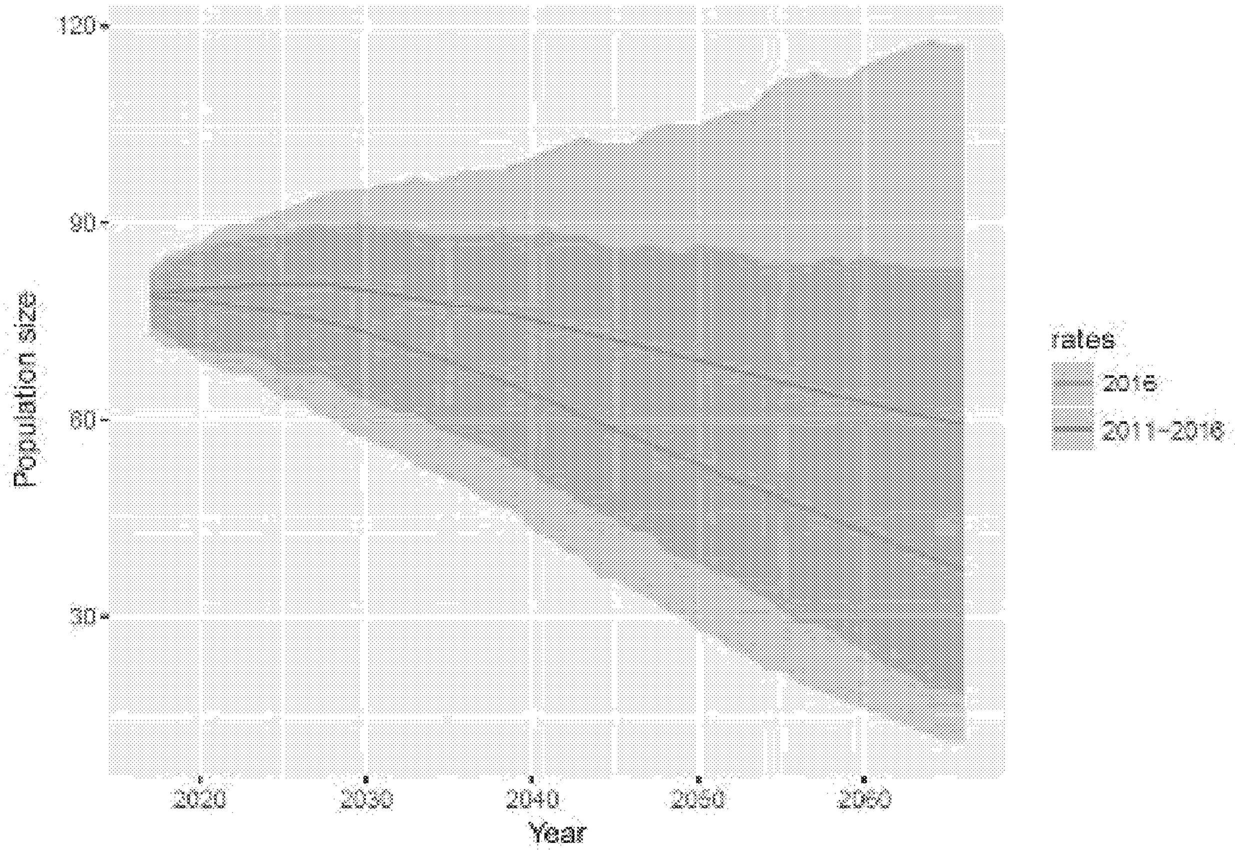

Figure 20. The SRKW population size projections from 2016 to 2066 using two scenarios: (1) Projections using demographic rates held at 2016 levels, and (2) projections using demographic rates from 2011–2016. The pink and blue lines represent the projection assuming future rates similar to those in 2016 and in 2011–2016, respectively (NMFS 2016b).

Although SRKWs consume a variety of fish species (22 species) and one species of squid (Ford et al. 1998; Ford et al. 2000; Ford and Ellis 2006; Hanson et al. 2010; Ford et al. 2016), salmon are their primary prey. Scale and tissue samples of prey remains collected from May to September indicate that the SRKW diet consists of a high percentage of Chinook salmon (monthly proportions as high as >90 percent) (Hanson et al. 2010; Ford et al. 2016). The diet data also indicate that the whales are consuming mostly larger (i.e., older) Chinook salmon. Ford et al. (2016) confirmed the importance of Chinook salmon to the SRKWs in the summer months using deoxyribonucleic acid (DNA) sequencing from whale feces. The DNA results showed that salmon and steelhead made up to 98 percent of the inferred diet, of which almost 80 percent were Chinook salmon. And based on genetic analysis of feces and scale samples, Chinook salmon from Fraser River stocks dominate the diet of Southern Residents in the summer (Hanson et al. 2010). Less than 3 percent each of chum salmon (*O. keta*), sockeye salmon, and steelhead were observed in fecal DNA samples collected in the summer months (May through September).

Coho salmon (*O. kisutch*) and steelhead are also found in the diet in spring and fall months when Chinook salmon are less abundant. Specifically, coho salmon contribute to over 40 percent of the diet in late summer, which is evidence of prey shifting at the end of summer towards coho salmon (Ford et al. 1998; Ford and Ellis 2006; Hanson et al. 2010; Ford et al. 2016). Prey remains and fecal samples collected in inland waters during October through December indicate that Chinook along with chum salmon are primary the contributors to the whales' diet in the fall (NWFSC 2017 unpubl. data). Preliminary analysis of prey remains and fecal samples sampled during the winter and spring in coastal waters indicated the majority of prey samples were Chinook salmon (80 percent of prey remains and 67 percent of fecal samples were Chinook salmon), with some steelhead, chum salmon, and halibut (NWFSC 2017 unpubl. data). More relevant to this analysis, Chinook salmon genetic stock identification from samples collected in winter and spring in coastal waters included 12 U.S. west coast stocks, and over half of the Chinook salmon consumed originated in the Columbia River (NWFSC 2017 unpubl. data) for the K and L pods (primarily fall-run stocks).

The results from these diet studies have not demonstrated that the Snake River fall Chinook ESU may be the most critical Chinook stock to the SRKW's diet; however, the Snake River ESU has been mentioned as a priority stock in a report recently released by NMFS and WDFW (2018). The report identifies the Chinook salmon stocks that are of most importance to the health of the Southern Resident populations along the West Coast (NMFS and WDFW 2018). These stocks were chosen by analyzing scat and prey scale/tissue samples to identify Chinook salmon stocks in the whales' diet, observing the killer whale body condition through aerial photographs, and estimating the spatial and temporal overlap with Chinook salmon stocks ranging from Southeast Alaska to California. Extra weight was given to the salmon runs that support the Southern Residents during times of the year when the whales' body condition is more likely reduced and when Chinook salmon may be less available, such as in winter months, when SRKWs are more likely to be feeding off of stocks returning to the Columbia. On the current list, Snake River fall Chinook were grouped together with the unlisted and very abundant Upper Columbia summer/fall Chinook run. Escapement of Snake River fall Chinook has increased substantially as a result of actions implemented since this species was first listed under the ESA in 1991. Those actions include improved structural and operational measures at mainstem dams, hatchery supplementation, flow operations to support spawning and incubation, and cool water releases from Dworshak Dam during the summer. As a result, Snake River fall Chinook counts at LGD have increased from an average of about 1,300 adults in the 1990s to 11,300 adults in the 2000s, to 37,100 adults in the 2010s, in spite of existing temperatures exceeding both the existing and proposed SSC for temperature throughout this period of time (Figure 21).

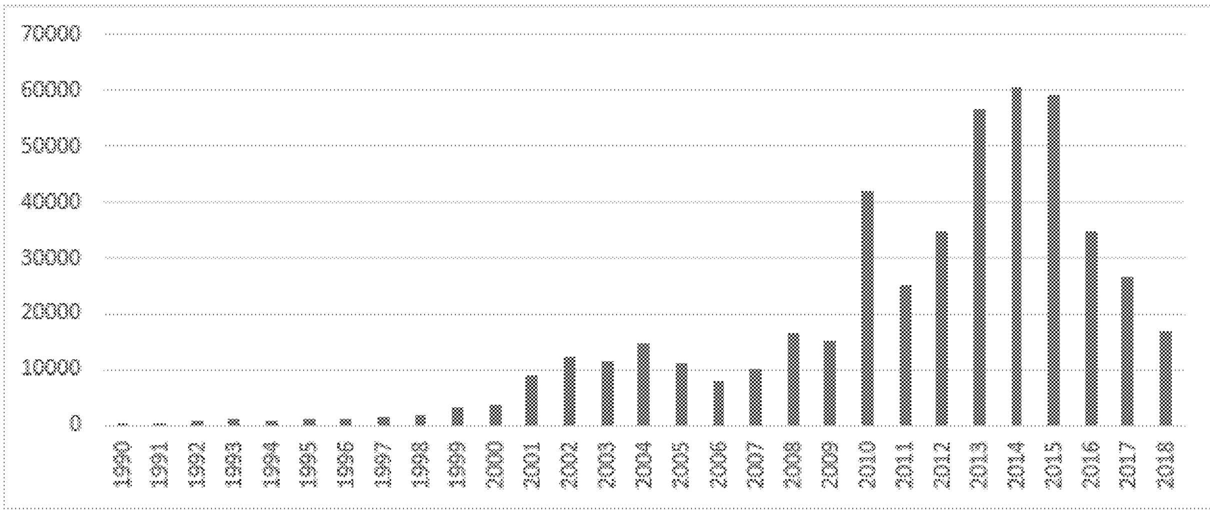

Figure 21. Total passage counts for adult Chinook at Lower Granite Dam from August 18th to December (i.e., fall Chinook passage dates) (1990-2018).

Given the diet study results noted above, the proposed action may affect SRKW through indirect effects to their primary prey. The proposed action is not anticipated to affect prey quality; however, the project may affect the quantity of prey available to SRKW. To assess the indirect effects of the proposed action on the SRKW DPS, we used the estimated loss of redd production described in the Effects section of this Opinion, and translate it to how many fewer adults you could expect to return from the affected redds/brood (which nearly equates to the loss of ocean-migrating adults due to the effects of the action). We do this by using the spawner-recruit relationship for Snake River fall Chinook using the Beverton Holt model. The model-fitting and selection process is described in the recently published Snake River fall Chinook Recovery Plan (NMFS 2017a). The fitted relationship is described by the following equation:

Recruits = (Alpha * Spawners) / (1+((Alpha/b)*Spawners)))

And where: Alpha = 1.65 and b = 8530

Based on the biological information described in the Effects section, our effects analysis demonstrates that, on average, about 3.4 percent of the Snake River fall Chinook spawning redd production could be affected or lost by the proposed action. We translate that to the maximum possible annual loss of returning adult Snake River fall Chinook salmon using the equation noted above and employing a number of assumptions. The assumptions we work under are that each spawner in the population has the same fecundity, fertilizes the same number of redds, and has the same reproductive success and that each redd produces the same number of offspring. If these assumptions were true, then the estimated loss of 3.4 percent of the redds, or production, under the proposed action equates to having 3.4 percent fewer returning spawners each year. From there we use the Beverton Holt model equation shown above to calculate the number of adult recruits under the existing condition vs. the number of adult recruits under the proposed SSC (with 3.4 percent fewer spawners), and then calculate the difference. Since the relationship is density-dependent (meaning that as you increase the number of spawners, you reach a point where the number of recruits per spawner starts to level off), the difference in the number of recruits under each scenario has to be calculated under a wide range of spawner abundances.

After going through the above steps, the results demonstrated that depending on the number of returning spawners, the proposed action could reduce the number of adult recruits by as few as five fish and by as many as 73 Chinook fish per year (NMFS, unpublished data). It should be noted that the Effects analysis (in terms of loss of redd production due to temperature effects) does not include hatchery fish which return as adults to the hatchery facilities but do not spawn naturally. These fish are also part of the ESU, but their production is not affected by the proposed action. However, these returning adults have survived through all of their life stages and are a part of the Snake River fall Chinook population found migrating through the range of Southern Resident killer whales that may be encountered as prey items. If these returning hatchery fish were included in the effects analysis, the calculated percentage of lost "production" for the ESU as a whole (including hatchery production) would be much smaller, and hence the percentage loss of potential food fish for SRKWs would also be smaller.

The maximum annual loss of 73 returning Snake River fall Chinook each year under the proposed action equates to less than 0.3percent of the total Snake River fall Chinook adult returns at Bonneville Dam (WDFW and ODFW 2019; NMFS 2017a). However, as stated above, the annual loss (and thus the percent loss to their potential prey) would actually be much, much lower. It is also extremely unlikely that the SRKW population would be capable of intercepting and feeding on all 73 (maximum – an extremely conservative estimate) of the Snake River fall Chinook lost due to the proposed action each year.

In summary, the maximum amount of take equates to 73 adult Chinook salmon per year, though this estimate is an overestimate as it assumes no contribution to production or recruitment by hatchery fish (which currently make up about 80 percent of the spawners upstream of LGD). This reduction (which is extremely conservative, as demonstrated in earlier discussion) is negligible and an extremely small percent of the total prey available to the whales in the action area. Therefore, NMFS anticipates that any salmonid take up to the aforementioned maximum extent would result in an insignificant reduction in prey resources for SRKW that may intercept these species within their range.

The SRKW critical habitat consists of three specific areas: (1) The Summer Core Area in Haro Strait and waters around the San Juan Islands; (2) Puget Sound; and (3) the Strait of Juan de Fuca. These areas comprise approximately 2,560 square miles of marine habitat. Based on the natural history of the Southern Residents and their habitat needs, NMFS identified the following PBFs essential to conservation: (1) Water quality to support growth and development; (2) Prey species of sufficient quantity, quality and availability to support individual growth, reproduction and development, as well as overall population growth; and (3) Passage conditions to allow for migration, resting, and foraging. The proposed action occurs outside designated critical habitat. However, a relatively very small amount of Upper Columbia/Snake River Chinook salmon are recovered in Puget Sound, especially relative to the proportion of Puget Sound Chinook salmon present (Weitkamp 2010). Because only a small proportion of Snake River fall Chinook are recovered in Puget Sound, the impact of the proposed action to critical habitat is insignificant.

Conclusions. Short-term effects are not anticipated and long-term effects to the SRKW prey base and prey feature of critical habitat are insignificant. Based on this analysis, NMFS concludes that the proposed action is not likely to adversely affect SRKW or their designated critical habitat.

3. MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT ESSENTIAL FISH HABITAT RESPONSE

Section 305(b) of the MSA directs federal agencies to consult with NMFS on all actions or proposed actions that may adversely affect EFH. The MSA (section 3) defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." Adverse effect means any impact that reduces quality or quantity of EFH, and may include direct or indirect physical, chemical, or biological alteration of the waters or substrate and loss of (or injury to) benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality or quantity of EFH. Adverse effects on EFH may result from actions occurring within EFH or outside of it and may include site-specific or EFH-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810). Section 305(b) also requires NMFS to recommend measures that can be taken by the action agency to conserve EFH.

This analysis is based, in part, on the EFH assessment provided by the NMFS and descriptions of EFH for Pacific Coast salmon (PFMC 2014) contained in the fishery management plans developed by the Pacific Fisheries Management Council and approved by the Secretary of Commerce.

3.1 Essential Fish Habitat Affected by the Project

The proposed action and action area for this consultation are described in the Introduction section to this document. The action area includes areas designated EFH for various life-history stages of two Pacific Coast salmon species Chinook salmon and coho salmon (PFMC 2014). Habitat areas of particular concern within the action area include spawning habitat for fall Chinook salmon (PFMC 2014).

Freshwater EFH for Pacific Coast salmon (Chinook and coho) consists of four major components: (1) Spawning and incubation; (2) juvenile rearing; (3) juvenile migration corridors; and (4) adult migration corridors and holding habitat, and overall, can include any habitat currently or historically occupied within Washington, Oregon, and Idaho. Pacific salmon marine EFH includes (1) estuarine rearing; (2) ocean rearing; and (3) juvenile and adult migration. Freshwater EFH found within the action area for this consultation includes all four components noted above for Chinook salmon but only juvenile migration and adult migration corridors for coho salmon. None of the components for Pacific salmon marine EFH are found within the action area. Detailed descriptions and identifications of EFH for salmon are found in Appendix A of Amendment 18 of the Pacific Coast Salmon Plan (PFMC 2014).

3.2 Adverse Effects on Essential Fish Habitat

As described in Section 2.5 of the preceding Opinion, the proposed action is expected to affect water temperatures in mainstem Snake River within the action area. As a result, we conclude that the proposed action will have the following adverse effects on EFH designated for both Chinook and coho salmon:

- Reduction in habitat quality in the adult migration corridor, which may cause a loss of gametes or reduction in gamete quality for a small proportion of the ESU which spawns on the earliest days of the spawning season and in the action area.

In addition, we conclude that the proposed action will have the following adverse effects on EFH designated for Chinook salmon:

- Reduced quantity and quality of rearing habitat for a small proportion of the eggs deposited in redds on the earliest days of the spawning season and in the action area due to higher than ideal temperatures for egg survival.

The effects of the proposed action on Chinook salmon habitat are discussed in detail in the preceding Opinion. EFH for coho salmon is also designated in the action area. Because the preceding opinion did not address effects to coho salmon and their habitat, and because coho salmon use the action area differently than Chinook salmon, we examine the potential for the proposed action to affect coho salmon here. Visual fish passage counts from the past 25 years indicates that anywhere between 50 to 90 percent of the Snake River coho run has passed Lower Granite Dam by mid-October and that some coho may move through the action area as early as mid-September and others as late as mid-November (Figure 22). Some of these coho salmon adults are headed to the Clearwater River and do not enter the action area, but others are headed to the Grande Ronde River and therefore do swim through a portion of the lower reach of the action area, which is typically 1–2°C cooler than the upper reach in early October. In order for the proposed temperature criteria to be met in the upper reach, temperatures could be as high as 19.1 on October 6th. Based on temperature data collected by the IPC, the highest 95th percentile difference between the daily maximum and daily average temperatures recorded in the upper reach was 0.56°C. Applying this to the 19°C daily average criterion, daily maximum temperatures in the upper reach could be as high as 19.6°C (or 19.9°C if applying the human use allowance) and still comply with criteria. However, temperatures in the lower reach, through which a portion of the Grande Ronde coho could be moving at this time, would be closer to 17 or 18°C maximum. Though this temperature is not ideal for adults migrating to spawning grounds, the migrating coho would not likely be holding in these temperatures for long as they are migrating to the Grande Ronde and then returning to their natal stream, the Lostine River, which is where the coho reintroduction program for the Grande Ronde is based. Temperatures in the Lostine are significant cooler than in the mainstem Snake or Grande Ronde Rivers.

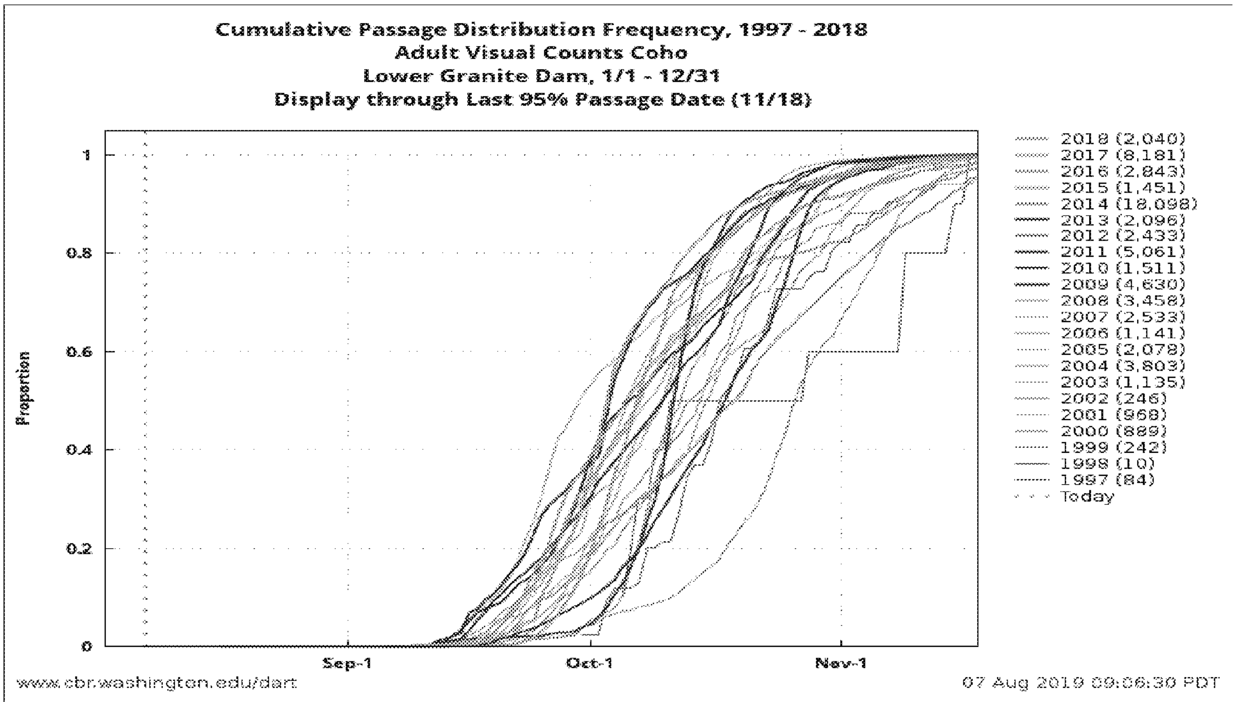

Figure 22. Cumulative proportion adult coho salmon passage at Lower Granite Dam based on visual fish counts (1994–2018).

3.3 Essential Fish Habitat Conservation Recommendations

NMFS believes that the following six Conservation Recommendations are necessary to avoid, mitigate, or offset the impact of the proposed action on EFH. These Conservation Recommendations are a non-identical set of the ESA Terms and Conditions included in the ITS of the above Opinion.

1. Consistent with IDEQ's regulations[12] and integrated reporting methods,[13] and the CWA[14] and its implementing regulations,[15] the IDEQ should apply the appropriate salmonid spawning criteria for the protection of any existing salmonid spawning use when and where the use is attained, such as in the portion of the mainstem Snake River from the confluence of the Salmon River to the confluence of the Clearwater River including the following segments of the Snake River: ID17060103SL004_08; ID17060103SL003_08; and ID17060103SL002_08, and ID17060103SL001_08. In the State's next triennial review, the IDEQ should review the available data and consider designating salmonid spawning in these segments through rulemaking. The IDEQ should share the data with

[12] Idaho Water Quality Standards (IDAPA 58.01.02.051.01): The existing in stream water uses and the level of water quality necessary to protect the existing uses shall be maintained and protected; and IDAPA 58.01.02.050.02.b: In all cases, existing beneficial uses of the waters of the state will be protected.
[13] Water Body Assessment Guidance (IDEQ 2016).
[14] Consistent with the goal of the CWA to restore and maintain the chemical, physical, and biological integrity of the nation's waters (Section 101(a)).
[15] 40 CFR 131.12(a)(1): Existing instream water uses and the level of water quality necessary to protect the existing uses shall be maintained and protected.

EPA, establish a milestone in the next PPA to provide updates of progress on its review, and provide such updates during the regular PPA check-ins.

2. The EPA and IDEQ should share with NMFS the results of any temperature monitoring conducted within the mainstem Snake River that are reported as part of the 401 certification and/or FERC relicensing for the HCC[16].

3. The EPA should share with NMFS the results of any fall Chinook salmon spawning surveys conducted within the mainstem Snake River that are part of the 401 certification and/or FERC relicensing for the HCC.[15]

4. The EPA should ensure NMFS receives a copy of the data collected in conservation recommendation 2 and 3 above.

5. To improve the quality of EFH and help advance the restoration of EFH for Chinook and coho salmon in Idaho, the EPA should use all of its available authorities to ensure TMDL's are effectively implemented to reduce water quality impacts from both point and nonpoint sources.

6. To improve the quality of EFH and help advance the restoration of EFH for Chinook and coho salmon in Idaho, the EPA should use all of its available authorities to ensure point source discharges are employing the most effective treatment technologies available.

Fully implementing these EFH conservation recommendations would protect, by avoiding or minimizing the adverse effects described in Section 3.2, above, approximately 108 RM of designated EFH for Pacific Coast salmon.

3.4 Statutory Response Requirement

As required by section 305(b)(4)(B) of the MSA, the EPA must provide a detailed response in writing to NMFS within 30 days after receiving an EFH Conservation Recommendation. Such a response must be provided at least 10 days prior to final approval of the action if the response is inconsistent with any of NMFS' EFH Conservation Recommendations unless NMFS and the EPA have agreed to use alternative time frames for the federal agency response. The response must include a description of measures proposed by the agency for avoiding, minimizing, mitigating, or otherwise offsetting the impact of the activity on EFH. In the case of a response that is inconsistent with the Conservation Recommendations, the federal agency must explain its reasons for not following the recommendations, including the scientific justification for any disagreements with NMFS over the anticipated effects of the action and the measures needed to avoid, minimize, mitigate, or offset such effects (50 CFR 600.920(k)(1)).

In response to increased oversight of overall EFH program effectiveness by the Office of Management and Budget, NMFS established a quarterly reporting requirement to determine how many conservation recommendations are provided as part of each EFH consultation and how

[16] The IPC has conducted annual temperature and redd monitoring since as early as 1991. NMFS anticipates this monitoring will continue into the future. The final 401 water quality certification requires temperature monitoring in the Snake River.

many are adopted by the action agency. Therefore, we ask that in your statutory reply to the EFH portion of this consultation, you clearly identify the number of conservation recommendations accepted.

3.5 Supplemental Consultation

The EPA must reinitiate EFH consultation with NMFS if the proposed action is substantially revised in a way that may adversely affect EFH, or if new information becomes available that affects the basis for NMFS' EFH Conservation Recommendations (50 CFR 600.920(l)).

4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

The DQA specifies three components contributing to the quality of a document. They are utility, integrity, and objectivity. This section of the Opinion addresses these DQA components, documents compliance with the DQA, and certifies that this Opinion has undergone pre-dissemination review.

4.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended users of this Opinion are the EPA and IDEQ. Other interested users could include the IPC. Individual copies of this Opinion were provided to the EPA and IDEQ. The format and naming adheres to conventional standards for style.

4.2 Integrity

This consultation was completed on a computer system managed by NMFS in accordance with relevant information technology security policies and standards set out in Appendix III, 'Security of Automated Information Resources,' Office of Management and Budget Circular A-130; the Computer Security Act; and the Government Information Security Reform Act.

4.3 Objectivity

Information Product Category: Natural Resource Plan.

Standards: This consultation and supporting documents are clear, concise, complete, and unbiased; and were developed using commonly accepted scientific research methods. They adhere to published standards including NMFS' ESA Consultation Handbook, ESA regulations, 50 CFR 402.01 et seq., and the MSA implementing regulations regarding EFH, 50 CFR 600.

Best Available Information: This consultation and supporting documents use the best available information, as referenced in the References section. The analyses in this Opinion and EFH consultation contain more background on information sources and quality.

Referencing: All supporting materials, information, data and analyses are properly referenced, consistent with standard scientific referencing style.

Review Process: This consultation was drafted by NMFS staff with training in ESA and MSA implementation, and reviewed in accordance with West Coast Region ESA quality control and assurance processes.

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